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Release 1.1

The *open*EHR Archetype Model

*open*EHR Archetype Profile

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a. Ocean Informatics

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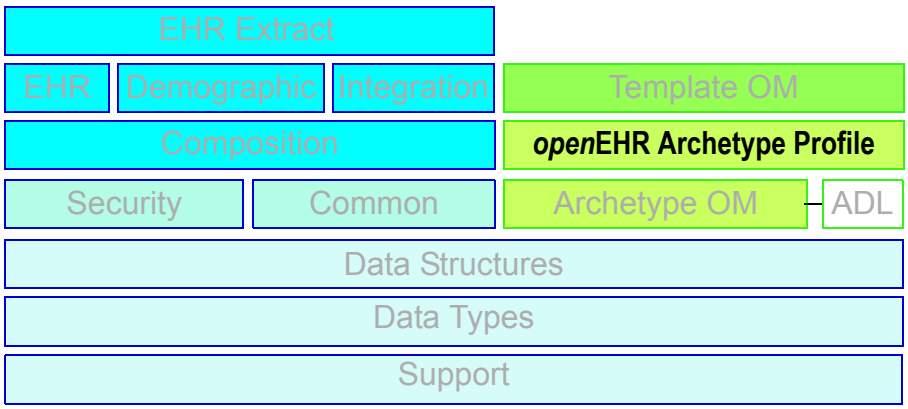

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Amendment Record

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	Original modelling work.	T Beale A Goodchild Z Tun D Kalra D Lloyd N Lea T Austin	June 2004

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1 Introduction

1.1 Purpose

This document describes the *open*EHR Archetype Profile (AP), which defines custom constraint classes for use with the generic archetype object model (AOM). The intended audience includes:

- Standards bodies producing health informatics standards
- Software development organisations using *open*EHR
- Academic groups using *open*EHR
- The open source healthcare community
- Clinical and domain modelling specialists.

1.2 Related Documents

Prerequisite documents for reading this document include:

- The *open*EHR Architecture Overview

Prerequisite documents for reading this document include:

- The *open*EHR Archetype Definition Language (ADL)
- The *open*EHR Archetype Object Model (AOM)

1.3 Status

This document is under development, and is published as a proposal for input to standards processes and implementation works.

This document is available at http://svn.openehr.org/specification/TAGS/Release-1.0.1/publishing/architecture/am/openehr_archetype_profile.pdf.

The latest version of this document can be found at http://svn.openehr.org/specification/TRUNK/publishing/architecture/am/openehr_archetype_profile.pdf.

1.4 Peer review

Known omissions or questions are indicated in the text with a “to be determined” paragraph, as follows:

TBD_1: (example To Be Determined paragraph)

Areas where more analysis or explanation is required are indicated with “to be continued” paragraphs like the following:

To Be Continued: more work required

Reviewers are encouraged to comment on and/or advise on these paragraphs as well as the main content. Please send requests for information to info@openEHR.org. Feedback should preferably be provided on the mailing list openehr-technical@openehr.org, or by private email.

2 Overview

2.1 Background

An underpinning architectural feature of *open*EHR is the use of archetypes and templates, which are formal models of domain content, and are used to control data structure and content during creation, modification and querying. The elements of this architecture are twofold.

- The *open*EHR Reference Model (RM), defining the structure and semantics of information in terms of information models (IMs). The RM models correspond to the ISP RM/ODP information viewpoint, and define the data of *open*EHR EHR systems. The information model is designed to be invariant in the long term, to minimise the need for software and schema updates.
- The *open*EHR Archetype Model (AM), defining the structure and semantics of archetypes and templates. The AM consists of the archetype language definition language (ADL), the Archetype Object Model (AOM) and the *open*EHR Archetype profile (oAP).

The purpose of the ADL is to provide an abstract syntax for textually expressing archetypes and templates. The AOM defines the object model equivalent of ADL. It is reference model-neutral, meaning that it can be used to express archetypes for any reference model in a standard syntax. ADL and the AOM are brought together in an ADL parser, i.e. any tool which can read ADL archetype texts, and whose parse-tree (resulting in-memory object representation) is instances of the AOM.

The purpose of the *open*EHR Archetype Profile, the subject of this document, is to define custom archetype classes and in some cases, custom syntax equivalents (essentially shorthands) that can be used instead of the AOM generic classes for archetyping certain RM classes.

2.2 Package Structure

The *open*EHR Archetype Profile model is defined in the package `am.openehr_profile`, illustrated in FIGURE 1. It is shown in the context of the *open*EHR am and `am.archetype` packages. The internal structure of the package mimics the structure of the reference model it profiles, i.e. the *open*EHR reference model. This is done to make software development easier, even though the package structure may be sparsely populated. Packages need only be defined where there are custom types to be defined; the only ones currently defined are in the `data_types` package.

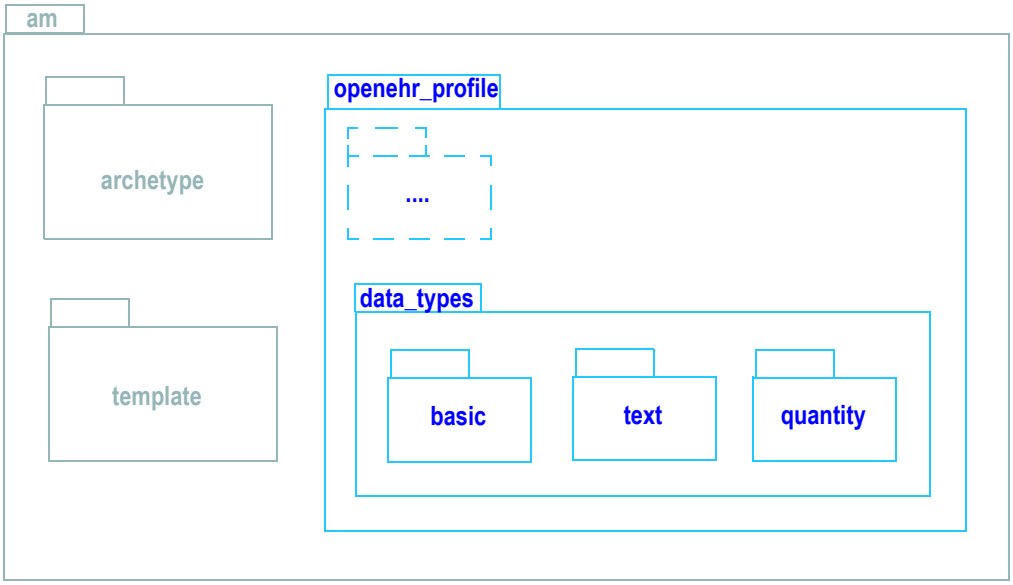

FIGURE 1 openehr.am.openehr_profile Package

3 Data_types.basic Package

The `am.openehr_profile.basic` package, illustrated in FIGURE 2, defines custom types for constraining the RM type `DV_STATE`.

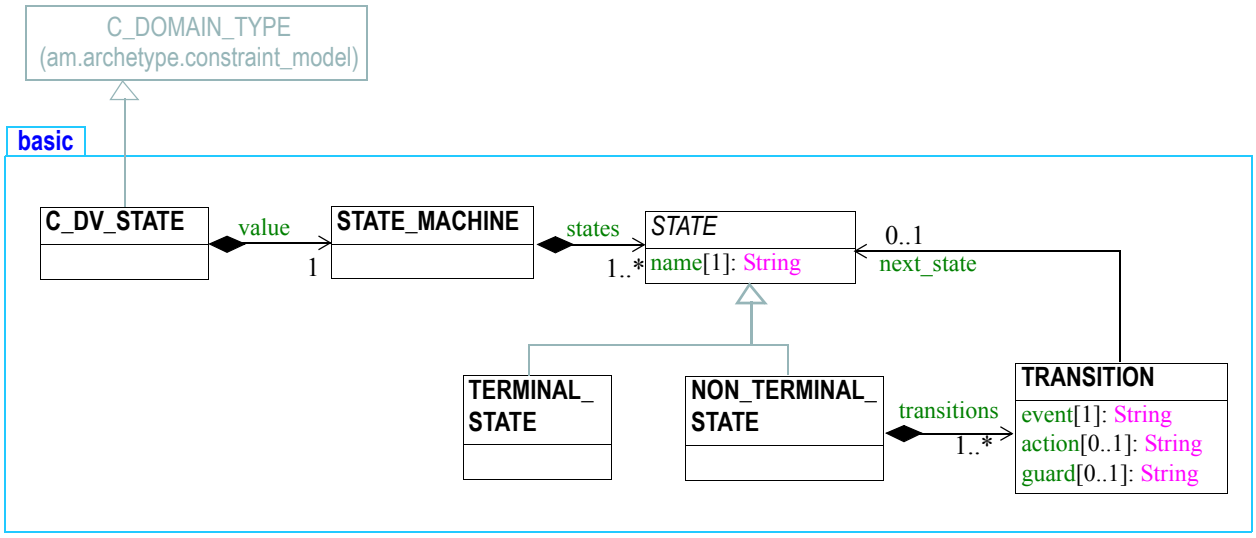

FIGURE 2 am.openehr_profile.data_types.basic Package

A example of a state machine to model the state of a medication order is illustrated in FIGURE 3. This state machine is defined by an instance of the class `STATE_MACHINE`. (Note that for general modelling of states of medications and other interventions, the standard state machine defined in the EHR IM should normally be used).

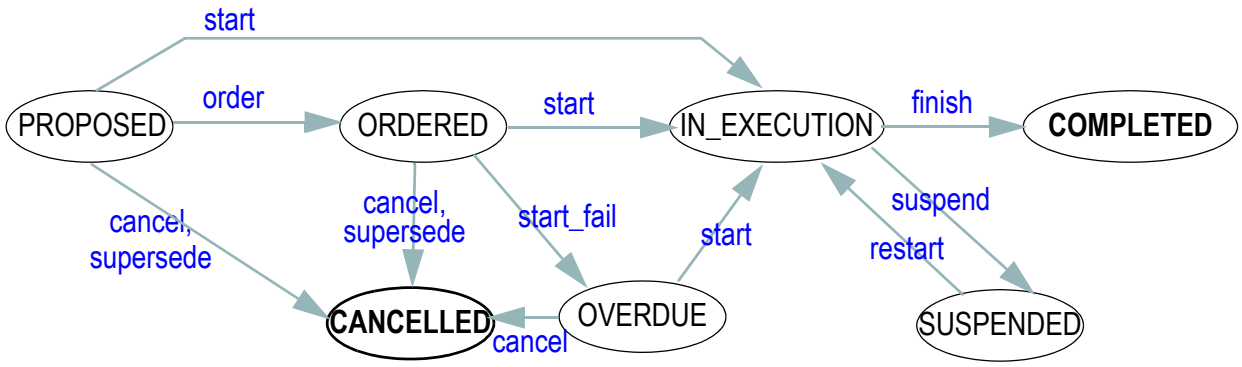

FIGURE 3 Example State Machine for Medication Orders

3.1 Class Descriptions

3.1.1 C_DV_STATE Class

CLASS	C_DV_STATE
Purpose	Constrainer type for `DV_STATE` instances. The attribute *c_value* defines a state/event table which constrains the allowed values of the attribute *value* in a `DV_STATE` instance, as well as the order of transitions between values.

CLASS	C_DV_STATE	
Inherit	C_DOMAIN_TYPE	
Attributes	Signature	Meaning
1..1	**value**: STATE_MACHINE	
Invariants	**value_exists**: value /= Void	

3.1.2 STATE_MACHINE Class

CLASS	STATE_MACHINE	
Purpose	Definition of a state machine in terms of states, transition events and outputs, and next states.	
Attributes	Signature	Meaning
1..1	**states**: Set <STATE>	
Invariants	***States_valid***: states /= Void **and then not** states.is_empty	

3.1.3 STATE Class

CLASS	*STATE (abstract)*	
Purpose	Abstract definition of one state in a state machine.	
Attributes	Signature	Meaning
1..1	**name**: String	name of this state
Invariants	***Name_valid***: name /= Void **and then not** name.is_empty	

3.1.4 NON_TERMINAL_STATE Class

CLASS	NON_TERMINAL_STATE	
Purpose	Definition of a non-terminal state in a state machine, i.e. one that has transitions.	
Inherit	STATE	
Attributes	Signature	Meaning
1..1	**transitions**: Set <TRANSITION>	
Invariants	***Transitions_valid***: transitions /= Void **and then not** transitions.is_empty	

3.1.5 TERMINAL_STATE Class

CLASS	TERMINAL_STATE	
Purpose	Definition of a terminal state in a state machine, i.e. a state with no exit transitions.	
Inherit	`STATE`	
Attributes	**Signature**	**Meaning**
Invariants		

3.1.6 TRANSITION Class

CLASS	TRANSITION	
Purpose	Definition of a state machine transition.	
Attributes	**Signature**	**Meaning**
1..1	**event**: `String`	Event which fires this transition
0..1	**guard**: `String`	Guard condition which must be true for this transition to fire
0..1	**action**: `String`	Side-effect action to execute during the firing of this transition
1..1	**next_state**: `STATE`	Target state of transition
Invariants	***Event_valid***: event /= Void **and then not** event.is_empty ***Action_valid***: action /= Void **implies not** action.is_empty ***Guard_valid***: guard /= Void **implies not** guard.is_empty ***Next_state_valid***: next_state /= Void	

4 Data_types.text Package

4.1 Overview

The `am.openehr_profile.data_types.text` package contains custom classes for expressing constraints on instances of the types defined in the rm.data_types.text package. Only one type is currently defined, enabling the constraining of `CODE_PHRASE` instances. It is illustrated in FIGURE 4.

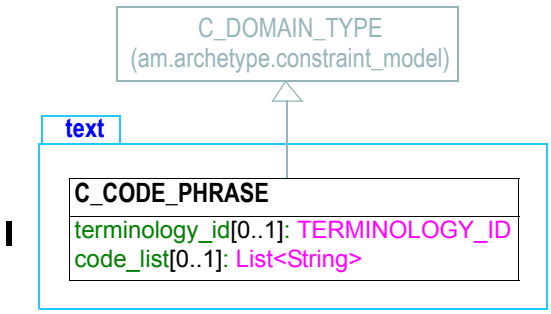

FIGURE 4 am.openehr_profile.data_types.text Package

4.2 Design

4.2.1 Standard ADL Approach

The generic kind of constraint that can be expressed for the `DV_CODED_TEXT` type can, like all standard archetype constraints, only include constraints on the attributes defined in the reference model type. This is illustrated by the following fragment of ADL:

```
DV_CODED_TEXT matches {
    defining_code matches {
        CODE_PHRASE matches {
            terminology_id matches {"xxxx"}
            code_string matches {"cccc"}
        }
    }
}
```

The standard approach allows the attributes *terminology_id* and *code_string* to be constrained independently, and would for example, allow *terminology_id* to be constrained to `ICD10|Snomed-ct|LOINC`, while *code_string* could be constrained to some particular fixed values. However, this makes no sense; codes only make sense within a given terminology, not across them. It also makes no sense to allow codes from more than one terminology, as terminologies generally have quite different designs - LOINC and Snomed-CT are completely different in their conception and realisation.

A more appropriate kind of constraint for `CODE_PHRASE` instances is for *terminology_id* to be fixed to one particular terminology, and for *code_string* to be constrained to a set of allowed codes; an empty list indicates that any code is allowed. These semantics are formalised in the class definition, shown below.

4.2.2 Inline dADL form

In an archetype, an instance of C_CODE_PHRASE can be included as inline dADL, as in the following example:

```
defining_code matches {
    C_CODE_PHRASE <
        terminology_id = <
            value = <"icd10">
        >
        code_list = <
            ["1"] = <"CF43.00">  -- acute stress reaction, mild
            ["2"] = <"F43.01">   -- acute stress reaction, moderate
            ["3"] = <"F32.02">   -- acute stress reaction, severe
        >
    >
}
```

4.2.3 Custom Syntax Form

The same constraint as above can be expressed used a custom syntax extension to ADL. This form is most usually used for expressing value-set constraints within an archetype.

```
defining_code matches {
    [icd10::
        F43.00, -- acute stress reaction, mild
        F43.01, -- acute stress reaction, moderate
        F32.02] -- acute stress reaction, severe
}
```

4.2.4 Archetype-local Codes

In either of the constraint forms above, the special terminology name “local” is recognised. This is used to indicate that the listed terms come from the ontology section of the archetype itself, rather than an external terminology, as in the following example:

```
defining_code matches {
    [local::
        at1311, -- Colo-colonic anastomosis
        at1312, -- Ileo-colonic anastomosis
        at1313, -- Colo-anal anastomosis
        at1314, -- Ileo-anal anastomosis
        at1315] -- Colostomy
}
```

4.2.5 Assumed value

The custom code syntax provides an equivalent of the assumed value notion from standard ADL by repeating the assumed value separated by the semi-colon (;) character, as in the following example:

```
defining_code matches {
    [local::
        at1311, -- Colo-colonic anastomosis
        at1312, -- Ileo-colonic anastomosis
        at1313, -- Colo-anal anastomosis
        at1314, -- Ileo-anal anastomosis
        at1315; -- Colostomy
        at1312] -- (assumed value)
}
```

4.2.6 Validity

The following validity rules apply to `CODE_PHRASE` constraints:

VCPCV: code phrase code validity: all codes included within the list of codes must be unique.

4.3 Class Descriptions

4.3.1 C_CODE_PHRASE Class

CLASS	C_CODE_PHRASE	
Purpose	Expresses constraints on instances of `CODE_PHRASE`. The *terminology_id* attribute may be specified on its own to indicate any term from a specified terminology; the *code_list* attribute may be used to limit the codes to a specific list.	
Inherit	`C_DOMAIN_TYPE`	
Attributes	**Signature**	**Meaning**
0..1	**terminology_id**: `TERMINOLOGY_ID`	Indentifier of terminology from which codes are taken.
0..1	**code_list**: `List<String>`	List of allowed codes; may be empty, meaning any code in the terminology may be used.
Functions	**Signature**	**Meaning**
(effected)	**any_allowed**: `Boolean` ***ensure*** Result = terminology_id = Void **and** code_list = Void	True if any `CODE_PHRASE` instance allowed.
Invariants	***List_validity***: code_list /= Void **implies** (**not** code_list.is_empty **and** terminology_id /= Void) ***Any_allowed_validity***: any_allowed **xor** terminology_id /= Void	

5 Data_types.quantity Package

5.1 Overview

The `am.openehr_profile.data_types.quantity` package is illustrated in FIGURE 5. Two custom types are defined: `C_DV_QUANTITY` and `C_DV_ORDINAL`.

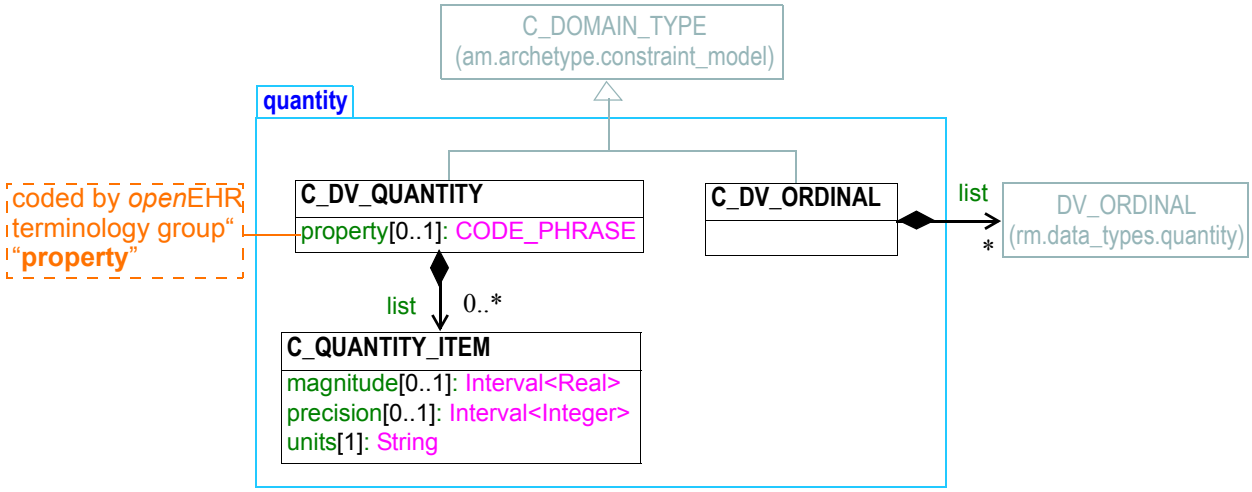

FIGURE 5 am.openehr_profile.data_types.quantity Package

5.2 Design - Ordinals

5.2.1 Standard ADL

An ordinal value is defined as one which is ordered without being quantified, and is represented by a symbol and an integer number. The `DV_ORDINAL` class can be constrained in a generic way in ADL as follows:

```
item matches {
    DV_ORDINAL matches {
        value matches {0}
        symbol matches {
            DV_CODED_TEXT matches {
                defining_code matches {[local::at0014]} -- no heartbeat
            }
        }
    }
    DV_ORDINAL matches {
        value matches {1}
        symbol matches {
            DV_CODED_TEXT matches {
                defining_code matches {[local::at0015]} -- less than 100 bpm
            }
        }
    }
    DV_ORDINAL matches {
        value matches {2}
        symbol matches {
            DV_CODED_TEXT matches {
```

```
                    defining_code matches {[local::at0016]} -- greater than 100
bpm
                }
            }
        }
    }
```

The above says that the allowed values of the attribute value is the set of ORDINALs represented by three alternative constraints, each indicating what the numeric value of the ordinal in the series, as well as its symbol, which is a CODED_TEXT.

5.2.2 Inline dADL Section

The above constraint can be represented as an inline instance of the *open*EHR type C_ORDINAL, as follows:

```
defining_code matches {
    C_DV_ORDINAL <
       list = <
          ["1"] = <
             value = <0>
             symbol = <
                defining_code = <[local::at0014]>      -- no heartbeat
             >
          >
          ["2"] = <
             value = <1>
             symbol = <
                defining_code = <[local::at0014]>      -- less than 100 bpm
             >
          >
          ["3"] = <
             value = <2>
             symbol = <
                defining_code = <[local::at0014]>-- greater than 100 bpm
             >
          >
       >
    >
}
```

5.2.3 Custom Syntax

A more efficient way of representing the same constraint is using the following ADL syntax:

```
item matches {
    0|[local::at0014], -- no heartbeat
    1|[local::at0015], -- less than 100 bpm
    2|[local::at0016]  -- greater than 100 bpm
}
```

5.2.4 Assumed Value

Assumed value is represented in the same way as in the custom code syntax, i.e. by adding a semi-colon demarcated value at the end of the list, as follows:

```
item matches {
    0|[local::at0014], -- no heartbeat
    1|[local::at0015], -- less than 100 bpm
    2|[local::at0016]; -- greater than 100 bpm
    0|[local::at0014]  -- (assumed value)
```

```
}
```

5.3 Design - Quantities

5.3.1 Standard ADL

A typical need in clinical and demographic data containing an *age* attribute is to be able to constrain it to different ranges depending on whether it is expressed in months (as is normally the case with infants) or years (for adults). If the age value is expressed using the *open*EHR DV_QUANTITY, this constraint can be expressed as follows:

```
age matches {
    DV_QUANTITY matches {
        property matches {[openehr::128]}
        units matches {"yr"}
        magnitude matches {|0.0..200.0|}
    }
    DV_QUANTITY matches {
        property matches {"time"}
        units matches {"mth"}
        magnitude matches {|3.0..12.0|}
    }
```

The above says that if units matches "years", the constraint on DV_QUANTITY.*magnitude* is 0 - 200, while if units is "months" then the *magnitude* constraint is 3 - 12. This approach is not particularly efficient or clear, since it allows multiple instances of the constraint on the *property* attribute, when in fact *property* can only sensibly be the same for all branches of the constraint.

5.3.2 Inline dADL Section

The above constraint can be represented as an inline instance of the type C_QUANTITY, as below. Note that an assumed value has been included as well, just using normal dADL.

```
age matches {
    C_DV_QUANTITY <
        property = <[openehr::128]> -- time
        list = <
            ["1"] = <
                units = <"yr">
                magnitude = <|0.0..200.0|>
                precision = <|2|>
            >
            ["2"] = <
                units = <"mth">
                magnitude = <|1.0..36.0|>
                precision = <|2|>
            >
        >
        assumed_value = <
            magnitude = <1.0>
            units = <"yr">
        >
    >
}
```

5.4 Class Definitions

5.4.1 C_DV_ORDINAL Class Definition

CLASS	C_DV_ORDINAL	
Purpose	Class specifying constraints on instances of DV_ORDINAL. Custom constrainer type for instances of DV_ORDINAL.	
Inherit	C_DOMAIN_TYPE	
Attributes	**Signature**	**Meaning**
1..1	**list**: Set<DV_ORDINAL>	Set of allowed DV_ORDINAL values.
Functions	**Signature**	**Meaning**
(effected)	**any_allowed**: Boolean ***ensure*** Result = list = Void	True if any DV_ORDINAL instance allowed.
Invariants	***Ordinals_valid***: list /= Void **xor** any_allowed ***Items_valid***: list /= Void **implies not** list.is_empty	

The following validity rules apply to DV_ORDINAL constraints:

VCOV: ordinal constraint value validity: the integer values of all ordinals included within the list must be unique.

5.4.2 C_DV_QUANTITY Class Definition

CLASS	C_DV_QUANTITY	
Purpose	Constrain instances of DV_QUANTITY.	
Inherit	C_DOMAIN_TYPE	
Attributes	**Signature**	**Meaning**
0..1	**list**: List<C_QUANTITY_ITEM>	List of value/units pairs.
0..1	**property**: CODE_PHRASE	Optional constraint on units property
Functions	**Signature**	**Meaning**
(effected)	**any_allowed**: Boolean ***ensure*** Result = list = Void **and** property = Void	True if any DV_QUANTITY instance allowed.

CLASS	C_DV_QUANTITY
Invariants	***List_valid***: list /= Void **implies not** list.is_empty ***Property_valid***: property /= Void **implies** terminology(Terminology_id_openehr).has_code_for_group_id (Group_id_property, property) ***Overall_validity***: (list /= Void **or** property /= Void) **xor** any_allowed

5.4.3 C_QUANTITY_ITEM Class Definition

CLASS	C_QUANTITY_ITEM	
Purpose	Constrain instances of `DV_QUANTITY`.	
Attributes	**Signature**	**Meaning**
0..1	**magnitude**: `Interval<Real>`	Constraint on the *magnitude* of the `DV_QUANTITY`.
0..1	**precision**: `Interval<Integer>`	Constraint on the *precision* of the `DV_QUANTITY`. A value of -1 means that precision is unconstrained.
1..1	**units**: `STRING`	Constraint on *units* of the `DV_QUANTITY`.
Functions	**Signature**	**Meaning**
	precision_unconstrained: `Boolean` **ensure** precision = -1 implies Result	True if no constraint on precision; True if *precision* = -1.
Invariants	***units_valid***: units /= Void **and not** units.is_empty	

6 Syntax Specification

The syntax described in this specification require some additions to the standard cADL grammar described in the *open*EHR ADL specification.

The additions to the grammar and lexical specificatoins for the standard cADL syntax are shown below. The actual grammar and lexical files used in the *open*EHR reference ADL parser (written in Eiffel) are available at http://my.openehr.org/wsvn/ref_impl_eiffel/TRUNK/components/adl_parser/src/syntax/cadl/parser/?rev=0&sc=0. The .l and .y files can be converted for use in other yacc/lex-based programming environments. The production rules of the .y file are available as an HTML document.

6.1 Grammar

The following shows additions to the standard cADL parser production rules (yacc specification) as of revision 158 of the Eiffel reference implementation repository (http://svn.openehr.org/ref_impl_eiffel).

```
c_object:
  c_complex_object
| archetype_internal_ref
| archetype_slot
| constraint_ref
| c_code_phrase           -- added
| c_ordinal               -- added
| c_primitive_object
| V_C_DOMAIN_TYPE
| ERR_C_DOMAIN_TYPE
| error

c_ordinal:
  c_ordinal_spec
| c_ordinal_spec ; integer_value
| c_ordinal_spec ; error

c_ordinal_spec:
  ordinal
| c_ordinal_spec , ordinal

ordinal:
  integer_value SYM_INTERVAL_DELIM V_QUALIFIED_TERM_CODE_REF

c_code_phrase:
  V_TERM_CODE_CONSTRAINT
| V_QUALIFIED_TERM_CODE_REF
```

6.2 Symbols

The following patterns are added to the lexical specification for the standard cADL grammar.

```
---------/* V_TERM_CODE_CONSTRAINT of form */ ----------------------
-- [terminology_id::code, -- comment
--             code, -- comment
--          code] -- comment
```

```
--
-- Form with assumed value
-- [terminology_id::code, -- comment
--          code; -- comment
--          code] -- an optional assumed value
--

\[[a-zA-Z0-9()._\-]+::[ \t\n]*                          -- pick up [ line

<IN_TERM_CONSTRAINT> {
    [ \t]*[a-zA-Z0-9._\-]+[ \t]*;[ \t\n]* -- pick up , line
    [ \t]*[a-zA-Z0-9._\-]+[ \t]*,[ \t\n]* -- pick up ; line
    \-\-[^\],\n]*\n                        -- do nothing
    [ \t]*[a-zA-Z0-9._\-]*[ \t\n]*\]       -- pick up ] line
}
```

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