openEHR
Release 1

Knowledge Artefact Identification

Editors: T Beale[a]		
Revision: 0.1	*Pages:* 25	*Date of issue:* 09 Jul 2009
Status: DEVELOPMENT		

a. Ocean Informatics

Keywords: EHR, health records, repository, governance

Copyright Notice

Amendment Record

Issue	Details	Who	Completed
0.1	Initial Writing	T Beale	09 Jul 2009

1 Introduction

1.1 Purpose

The purpose of this document is to describe an identification system for *open*EHR knowledge artefacts, i.e. archetype, template and terminology subsets. This includes such artefacts created by the *open*EHR Foundation itself, as well as any other organisation. The system can be applied to any artefact type founded on the principle of two-level modelling.

Unless otherwise stated, in this document, the term 'artefact' refers specifically to these artefact types.

1.2 Related Documents

This document is part of a framework of documents for which the core document is the following:

- Distributed Development and Governance Model.

1.3 Status

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

The latest version of this document can be found in PDF format at http://www.openehr.org/svn/specification/TRUNK/publishing/architecture/am/id_system.pdf. New versions are announced on `openehr-announce@openehr.org`.

1.4 Changes to *open*EHR Release 1.0.2

The changes required to *open*EHR Release 1.0.2 (ADL/AOM 1.4) to enable the globalised identification system described here include:

- augmented form of `ARCHETYPE_ID` to include organisational / package namespace, e.g.
  `org.openehr.ehr::openEHR-EHR-EVALUATION.problem.v1`
- concept name section of archetype identifiers (middle part of `ARCHETYPE_ID`) now relaxed to no longer require structure based on specialisation parents, e.g. ‘problem-diagnosis’ can now just be ‘diagnosis’, or any name preferred by designers;
- addition of `commit_id` sub-section archetype `description` section;
- addition of `id_history` sub-section to `description` section, e.g.
  `id_history = <"se.skl.epj::openEHR-EHR-EVALUATION.problem.v1">`

In addition the following features are required in forthcoming ADL/AOM 1.5 specifications:

- an optional `configuration` section is defined for operational archetypes and templates, allowing the exact list of source archetypes including version, revision and commit to be included.

2 Introduction

2.1 The Problem

The main requirement of an identification system for *open*EHR knowledge artefacts is to ensure that artefacts are correctly distinguishable both at the point of use as well as within the production environment. This entails not only defining how artefacts are identified, but how they are referenced from other artefacts and from data. Identification is needed for source as well as operational (built) artefacts. Revisions need to be handled properly, as well as qualification for global uniqueness.

2.2 Ontological versus Machine Identifiers

There are two general approaches to identification. The first is the one used in software development: the ontological, human-readable identifier approach, described in the *open*EHR Distributed Development and Governance Model. The second is the use of machine processable identifiers such as ISO Oids and GUIDs with accompanying dereferencing mechanisms. The two approaches are not mutually exclusive, but neither are they equivalent.

An ontological identification scheme supports hierarchy, multi-dimensional concept spaces, flexible versioning, and formally reflects the artefact authors' and users' understanding of the concept space being modelled. Ontological identification supports many types of computational processing. A typical ontological software artefact identifier is Within the software world, ontological style identifiers are used for both source artefacts and built components such as libraries and executables, although the details of the respective types of identifier may differ.

Machine identifiers on the other hand are not human-readable, do not directly support versioning, but do enable various useful kinds of computation. They require mapping to convert to ontological identifiers.

It is possible to define an identification scheme in which either or both ontological and machine identifiers are used. If machine identification only is used, all human artefact 'identification' is relegated to meta-data description, such as names, purpose, and so on. One problem with such schemes is that meta-data characteristics are informal, and therefore can clash – preventing any formalisation of the ontological space occupied by the artefacts. Discovery of overlaps and in fact any comparative feature of artefacts cannot be formalised, and therefore cannot be made properly computable.

In this document it is assumed that the primary identification scheme is based on ontological identifiers.

3 Source Artefact Identification Model

3.1 Overview

The general approach for identifying source artefacts is with an ontological identifier, prefixed by a namespace identifier if the artefact is managed within a Publishing Organisation or in some other production environment. The lack of a namespace in the identifier indicates an *ad hoc*, uncontrolled artefact, but its presence does not guarantee any particular kind of 'control' - quality can only be inferred if the PO is accredited with a central governance body as using a minimum quality process.

Different types of `ontological_id` are used for archetypes, templates and terminology subsets. The following sections describe the formal details of this identification scheme, and how it supports referencing between artefacts.

3.2 Formal Model

Both controlled and uncontrolled knowledge artefact identifiers are distinguished in *open*EHR. They are defined as follows:

```
source_artefact_id: source_qualified_id | source_uncontrolled_id
source_qualified_id: name_space_id '::' ontological_id
source_uncontrolled_id: ontological_id
name_space_id: publisher_org_id '.' library_id { '.' package_id }*

publisher_org_id: V_REVERSE_DOMAIN_NAME
library_id: V_ALPHANUMERIC_NAME
package_id: V_ALPHANUMERIC_NAME

V_ALPHANUMERIC_NAME: [a-zA-Z][a-zA-Z0-9_]+
V_REVERSE_DOMAIN_NAME:
```

Note that the `name_space_id` is constructed from a publisher organisation identifier plus at least one level of library/package identification. The latter condition ensures that a PO that starts with only one 'library' can always evolve to having more than one.

All archetypes and templates should be identified with this style of identifier. Any archetype or template missing the `name_space_id` part is deemed to be an uncontrolled artefact of unknown quality.

3.3 Library and Package Identification

Libraries are top-level packages, and are identified using a string name. A fully qualified library identifier is a dot-separated identifier normally commencing with the reverse domain name of the Publishing Organisation, followed by a Library identifier. Examples:

`org.openehr.`**`ehr`** - EHR archetypes library at *open*EHR.org
`org.openehr.`**`demographic`** - demographics library at *open*EHR.org
`uk.nhs.`**`maternity`** - maternity library at UK NHS
`edu.nci.`**`cancer_studies`** - cancer studies library at US National Cancer Institute

Since packages are a hierarchical construct, a qualified package name with respect to a top-level package within a Library is a dot-separated name, such as:

```
cancer_studies.melanoma
```

A fully qualified package name includes the fully qualified PO identifier, e.g.:

`edu.nci.`**`cancer_studies.melanoma`** `- melanoma` studies at US National Cancer Institute

3.4 Ontological Identifier

The following types of ontological identifier are defined:

```
ontological_id: archetype_id
              | template_id
              | subset_id
              | query_id
```

3.4.1 Archetype Identifier

The existing *open*EHR `ARCHETYPE_ID` is understood as the ontological identifier of an archetype within the concept space in which it was authored. The same kind of identifier has been proposed for `TEMPLATE_ID` and would serve the same purpose for templates. For both archetypes and templates, a notion of 'version' is incorporated in the identifier, meaning that a new 'version' is a new archetype or template. Therefore, when we speak of an 'artefact', we are speaking of a 'version'. This notion of version can be thought of as a 'major version' concept, or 'variant' idea.

3.4.1.1 Formal Definition

The archetype ontological identifier is defined by the following grammar, which is a slightly simplified version of the grammar for the `ARCHETYPE_ID` type defined in the *open*EHR Support IM specification:

```
archetype_id: qualified_rm_entity '.' domain_concept '.' version_id
qualified_rm_entity: rm_originator '-' rm_name '-' rm_entity
rm_originator: V_ALPHANUMERIC_NAME
rm_name: V_ALPHANUMERIC_NAME
rm_entity: V_ALPHANUMERIC_NAME
domain_concept: V_SEGMENTED_ALPHANUMERIC_NAME
version_id: 'v' V_NONZERO_DIGIT [ V_NUMBER ]

V_SEGMENTED_ALPHANUMERIC_NAME: [a-zA-Z][a-zA-Z0-9_-]+
V_NONZERO_DIGIT: [1-9]
V_NUMBER: [0-9]+
```

The field meanings are as follows:

rm_originator: id of organisation originating the reference model on which this archetype is based;

rm_name: id of the reference model on which the archetype is based;

rm_entity: ontological level in the reference model;

domain_concept: the domain concept name, including any specialisations;

version_id: numeric version identifier.

> **NB:** this is a simplified but backwardly compatible form of the grammar in Release 1.0.2 *open*EHR, Support IM specification.

The basic form of the structure is 2-part - an identifier for a reference model class followed by an identifier of the domain concept defined by the archetype, based on the class.

3.4.1.2 Reference Model Part

The first part takes the form of a 3-part identifier, such as:

```
openEHR-EHR-EVALUATION
```

This historically has been used in *open*EHR to identify the reference model class on which an archetype is based. It includes the publisher of the reference model (e.g. "*open*EHR"), which reference model is being referred to (in case there are more than one), and finally which class. A more modern approach might have been to use the fully qualified class identifier used in *open*EHR and in normal software, e.g.

```
org.openehr.rm.composition.content.entry.EVALUATION
```

However, this appeared unnecessarily long given that in most if not all reference models that could conceivably be used for archetyping, class names would be unique. As no problems have appeared with the short form used historically within *open*EHR, it is retained here.

3.4.1.3 Domain Concept Part

The second part of the identifier is the domain concept identifier. Domain concept identifiers are natural language words or phrases, often shortened to a mnemonic form, e.g. "bp_measurement". The equivalent in mainstream ICT is the way classes or modules are named in object-oriented languages, e.g. "LinkedList", "PacketHandler".

For specialised archetypes, they currently (up to *open*EHR Release 1.0.2) take the form of a series of such words, separated by '-' characters, where each segment corresponds to a parent archetype concept. This, the concept 'problem-diagnosis' is a 'diagnosis' specialisation of a 'problem' archetype.

If rigidly applied (as in the past), this system of concept naming creates the problem of how to identify two 'diagnosis' specialisations of two 'problem' archetypes from different publishers, e.g. having the identifiers:

uk.nhs.clinical::openEHR-EHR-EVALUATION.problem.v1

and

org.openehr.clinical::openEHR-EHR-EVALUATION.problem.v1

If the UK NHS wanted to create 'diagnosis' specialisations of both of these, the identifier would be:

uk.nhs.ehr::openEHR-EHR-EVALUATION.problem-diagnosis.v1

for both, which is clearly not useful, since the 'problem' part of the concept identifier is on its own insufficient to indicate which of the two 'problem' archetypes is the parent.

An approach that will avoid this problem is to consider the domain concept identifier as a single level identifier that does not try to reference any parent identifier, nor imply any particular level of specialisation. The two specialisations would then be named freely according to their purpose or contents, e.g.

```
uk.nhs.clinical::openEHR-EHR-EVALUATION.diagnosis.v1
```

and

```
org.openehr.clinical::openEHR-EHR-EVALUATION.cancer_diagnosis.v1
```

To allow for the fact that legacy specialised archetypes do in fact include the '-' style of separated domain concept identifier, the '-' character would still be allowed, but would no longer have any semantic significance. The consequence is that for archetypes in the future, the level of specialisation cannot be determined solely from the identifier.

This new approach is in line with how source artefacts are named in object-oriented languages, including the use of namespaces.

One thing that is missing in mainstream software that may be attractive with semantic artefacts like those described here is to define a formal ontology space in which artefact concept names are situated. This would potentially provide a) better guidance on nameing artefacts and b) a capability to make inferences e.g. for assessing dependencies.

3.4.2 Template Identifier

Within a given publishing space, template ontological identifiers are defined the same way as archetype identifiers, i.e.:

```
template_id: qualified_rm_entity '.' domain_concept '.' version_id
```

3.4.3 Subset Identifier

Terminology subsets are a relatively new type of artefact, both in *open*EHR and in the ICT industry in general. An initial proposal for a subset identifier following the same precepts as for archetypes and templates described in this specification is as follows:

```
subset_id: qualified_terminology_id '.' domain_concept '.' version_id
qualified_terminology_id: terminology_originator '-' terminology_name
terminology_originator: V_REVERSE_DOMAIN_NAME
terminology_name: V_ALPHANUMERIC_NAME
```

This leads to identifiers lke the following:

```
org.ihtsdo-snomed_ct.blood_phenotype.v2 -- Snomed Blood type subset
int.who-icd10.bacterial_infections.v13 -- ICD10 bacterial infections subset
```

An alternative identification approach within the SNOMED-CT terminology is likely to be a SNOMED code for each subset. However, the identification system used in *open*EHR must work for all terminologies, including those published within government or local organisations.

3.4.4 Query Identifier

There has been little experience with identification of queries as a designed artefact, mainly because queries in most systems are written in SQL and are not portable to any other system, being based on the local database structure. *open*EHR data queries, written in AQL or a similar formalism are portable across systems, and therefore do not need to be re-designed for each environment.

TBD_1: ontological id for queries

3.5 Artefact-level Revisions

Unlike software artefacts in most modern versioning systems, *open*EHR knowledge artefacts (i.e. particular 'versions' as defined above) are individually version-controlled. This is because an archetype or a template can in general make sense and be used on its own. Therefore, within a controlled Library, two extra numbers are defined for any particular copy of an archetype or template, as follows:

- revision number
- commit number

The revision number is incremented whenever a changed form of an archetype is published that contains only compatible changes according to the formal definition of 'revision' in DOC REF.

The commit number is used to track changes internally within an authoring environment, and is incremented for every change committed into the environment, no matter how small.

Neither the revision nor the commit number form part of the source artefact identifier, but they may be used in compiled artefacts, or as part of filenames on the file system.

3.5.1 Version, Revision and Commit Numbering Rules

The following rules are used to determine how to increment version, revision and commit number.

Version id rule: the version number starts at 0, and is incremented whenever an archetype is changed in a way that prevents it from being backwards compatible with data created by previous versions.

.v0 rule: all archetypes have this version on initial creation, before being accepted by the collaborative authoring environment;

revision id rule: revision number starts at 0 and is incremented whenever a backwards compatible change is made that affects the structure – by widening constraints and/or adding new nodes;

commit id rule: commit number starts at 0 and increments for any change at all to an archetype, including changes to meta-data, addition of translations and so on.

An archetype will start its life as a ‘v0’ artefact, and with no namespace. In this form, it can have any number of revisions and commits. It may be maintained for some time outside a Publishing Organisation, or it may be offered to a PO, where it will initially become part of an ‘alpha’ development area. where it will remain until its identifier and location in the package and Library structure is stablised.

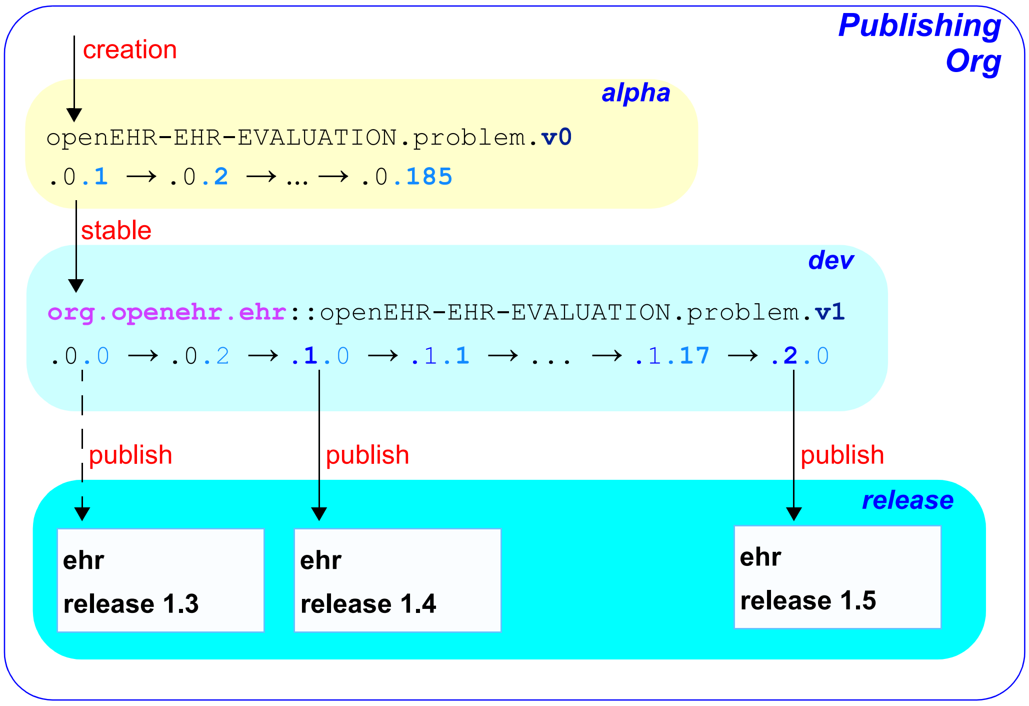


FIGURE 1 Succession of version, revision and commit changes

Once stable, an alpha archetype will migrate to the main ‘dev’ area, where it will be given a namespace prefix and have its version incremented to ‘v1’. At this point it could be published into the ‘release’ area, or alternatively, further development may occur before publishing. Whenever the revision is changed, due to a backwards-compatible structural change, the archetype should be re-published, enabling the community to have access to the latest form of the archetype.

During development, each change will increment the commit number. Whenever an archetype is published, the commit number is reset to 0.

NB: Revisions and commit numbers are not part of the ontological identifier of an artefact, but may be part of identifiers used for physical instances of such artefacts, e.g. files.

FIGURE 1 illustrates the trajectory of an *open*EHR archetype through various versions, revisions and commits.

3.6 File System Artefact Identification Recommendations

*open*EHR archetypes and templates can be represented on the file system as normal text files. How such files are identified depends on the intended use of the files. Two additions to the identifiers defined above are useful for file-system purposes:

- the use of *type extension*, to distinguish the various source and operational forms of the same artefact, in the usual manner of file naming;
- the use of a *directory structure* to aid human and tool use of large numbers of artefacts, particularly in shared files systems, e.g. version controlled repositories.

It would obviously be possible to represent artefacts on a file system using meaningless filenames and no directory structure, or an *ad hoc* structure, and to determine the identifier and relationships of the artefacts by inspecting each file. However this is not likely to be convenient for any use other than by specific tools that make this assumption. For human manual access to the artefacts, meaningless filenames will clearly be an obstruction, and the lack of directory structure might also be problematic, if there are large numbers of artefacts.

3.6.1 Source Development

Knowledge artefacts will typically be represented on the file system in source development and release areas within Publishing Organisations and also Enterprise Source Repositories, although this is not mandatory - databased approaches are equally valid.

Where the file system is used, the situation is similar to that for software:

- directories are used to represent namespaces and package structures;
- namespace is used as a basis for creating the top-level directory structure;
- filenames can exclude the namespace, in the same way as is done with class files in a programming environment;
- filenames use a standard extension for each kind of source artefact (defined by tools or standards);
- the current set of files represents the latest revision that has been locally created or downloaded from elsewhere. For archetypes and templates, this means that the most recent revisions and commits overwrite earlier ones.

An additional structural feature stemming from the fact that archetypes and templates are based on an underlying reference model is that the package structure of the reference model can also be manifested as a directory structure. This is not mandatory, but may be helpful to tools and human users.

In a source area containing artefacts whose identifiers lack a namespace, the latter should be placed in a separate directory called 'uncontrolled'.

A typical directory layout of archetypes according to the above precepts is illustrated below.

```
uk.nhs                                  // knowledge Publishing Org
    +--clinical                         // library
    |  +--org.openehr                   // RM issuer
    |     +--ehr                        // RM model
    |     |  +--composition             // RM package / class
    |     |  +--entry                   // composition.content.entry
```

```
        |     |  |  +--action         // composition.content.entry.action
        |     |  |  +--instruction    // etc
        |     |  |  +--observation
        |     |  |     +--openEHR-EHR-OBSERVATION.bp_measurement.v1.adls
        |     |  |
        |     |  +--section
        |     |  +--item_structure
        |     |     +--cluster
        |     |
        |     +--demograhic
        |        +--party
        |
        +--research
           +--org.openehr
              +--ehr

    org.openehr                       // knowledge Publishing Org
        +--clinical                   // library
        |  +--org.openehr             // RM issuer
        |     +--ehr                  // RM model
        |     |  +--composition       // RM package / class
        |     |  +--entry             // composition.content.entry
        |     |  |  +--action         // composition.content.entry.action
        |     |  |  +--observation
        |     |  |     +--openEHR-EHR-OBSERVATION.heart_rate.v1.adls
```

Note that the RM package structure from *open*EHR is not religiously adhered to in this example, but used in an elided form for convenience.

Other structures would clearly be possible. If no directory structure is used to indicate namespace structure, then fully qualified filenames are recommended, such as:

```
    org.openehr.clinical~openEHR-EHR-OBSERVATION.heart_rate.v1.adls
```

Note that the '~' character replaces the '::' used in *open*EHR for namespace separation, because the Windows operating system does not allow it in filenames.

4 Operational Artefact Identification

4.1 Overview

TBC

4.2 File-system Identifiers

In an operational context, such as a build server, there is most likely no real utility in separating artefacts into separate directories, and it may be convenient to have them in a completely flat structure, using similar filenames as above, e.g.:

```
archetypes
    +--uk.nhs.clinical~openEHR-EHR-OBSERVATION.bp_measurement.v1.adl
    +--org.openehr.clinical~openEHR-EHR-OBSERVATION.heart_rate.v1.adl
    ...
templates
    +--uk.nhs.clinical.maternity~openEHR-EHR-COMPOSITION.exam.v1.opt
```

Note that here that the '.adl' and '.opt' extensions are used for operational ADL and template files respectively.

Structures such as the above would typically recur under 'tag', 'release' and 'branch' directories corresponding to specific releases and branches of a baseline of artefacts.

5 Referencing

This section describes under what circumstances, and how artefact identifiers and their component parts are used when those artefacts need to be referenced by other artefacts, data or applications.

5.1 Source Artefacts

5.1.1 Between Archetypes - Slots

Archetypes reference each other via assertions in their slot statements. These are almost always regular expressions on the allowed archetype identifiers. Such patterns can either:

- include a namespace, in which case they are limited to archetypes from that namespace;
- or include no namespace, in which case they will resolve to any matching archetypes within the local Library.

No revision or commit numbers should be used in slot references. The model of a regex pattern is any pattern based on the `artefact_id` form of identifier, i.e.:

```
    [name_space_id '::'] ontological_id
```

TBD_2: examples

5.1.2 Between Specialised Archetypes

A specialised archetype can refer to its parent in three possible ways:

- If the child is uncontrolled, with an unqualified identifier. This is always assumed to come from the current Library. If it cannot be resolved to the current library, an error is reported.
- With a qualified identifier, where the qualifier is the same as the referencing archetype. This also resolves to the latest revision of the referenced archetype, in the current Library. If not found, an error should be reported.
- With a qualified identifier where the qualifier is of Library different from that of the referencing archetype. This resolves against the latest revision of the referenced archetype in the locally available copy of the referenced Library. If not found, an error should be reported.

The form of reference used in specialised archetypes to indicate the parent is therefore the `archetype_id` form, i.e. either a controlled or uncontrolled identifier. The following figure shows a number of archetypes related by specialisation.

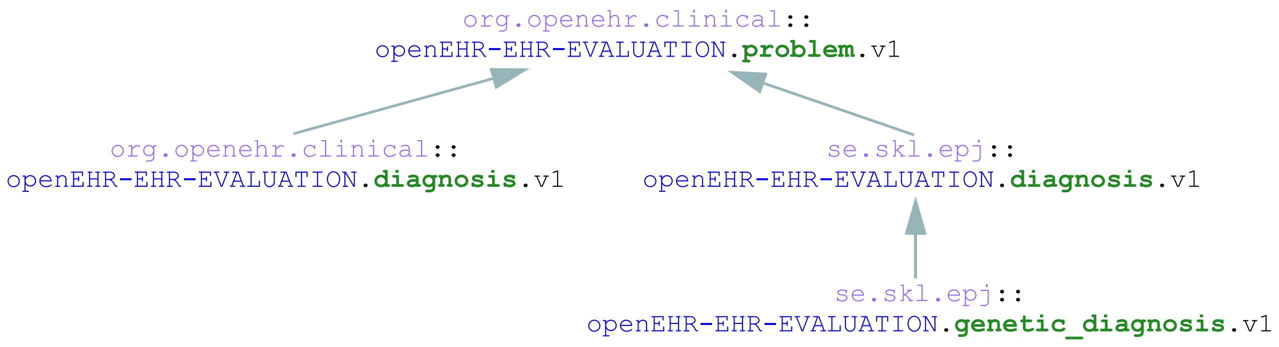

org.openehr.clinical::
openEHR-EHR-EVALUATION.problem.v1
org.openehr.clinical::
openEHR-EHR-EVALUATION.diagnosis.v1
se.skl.epj::
openEHR-EHR-EVALUATION.diagnosis.v1
se.skl.epj::
openEHR-EHR-EVALUATION.genetic_diagnosis.v1

FIGURE 2 Specialisation relationships

In this figure, specialisation is indicated by a reference to the parent archetype. For example:

- **`org.openehr.clinical::openEHR-EHR-EVALUATION.diagnosis.v1`**
  ```
  specialise
      org.openehr.clinical::openEHR-EHR-EVALUATION.problem.v1
  ```

One question that naturally arises to do with specialisation is what happens when the parent archetype is revised. The approach is the same as for object-oriented software: all archetypes in a given 'check-out' or release must always compile at any point in time to be valid. If a revised parent is introduced that invalidates a number of child archetypes in some way, revisions must be made to the children before the repository becomes valid as a whole again.

5.1.3 Between Archetype Historical Namespaces

When an archetype is moved from its original PO (e.g. a local health authority, or a specialist peak body) to a more central authoring domain (e.g. a national library, *open*EHR.org) its namespace will be changed to the new domain, as part of the review and handover process. The archetype's semantic definition may or may not change. In order for tools to know that an archetype was not created new locally, but was moved from another PO, an explicit reference statement can be made in the archetype in the description section of an archetype as follows:

```
    id_history = <"se.skl.epj::openEHR-EHR-EVALUATION.problem.v1">
```

TBD_3: rules for other changes in id

TBD_4: rules for changed level of specialisation

TBD_5: refer to specific revision?

5.1.4 Template to Archetype References

As with archetype-archetype referencing, templates refer to archetypes using their identifiers. These are resolved against the current and other installed Libraries. The reference is of the same form as for archetype references, i.e. the `archetype_id`.

There appears to be no point including archetype revision information within a template source, since this creates a version management problem when multiple templates within a Library start to refer to different versions of archetypes, which are unlikely to be simultaneously available, or even mutually coherent. Instead, template references to archetypes are assumed to be resolved at compilation time, just as for archetype – archetype references.

5.1.5 Templates to Templates

Templates can refer to templates to indicate inclusion. The reference approach is the same as for template to archetype references, i.e. the use of the `template_id`.

5.2 Operational Artefacts

Operational artefacts such as operational archetypes and templates generated by the Compiler tools are built from source artefacts, including by reference resolution from within some source artefacts to others within the current configuration of the local and imported Libraries. The particular versions of reference targets are determined by the contents of the configuration, and are thus a function of version management activities, in the same way as for software development.

When an operational artefact is generated from controlled source artefacts (i.e. within a Publishing Organisation), it is possible to include the fine-grained revision information from the relevant source artefacts, so that the operational form describes exactly which set of source artefacts were used to produce it. The source artefact semantic signatures can also be included. This information can be included in a configuration section of the artefact. This would be expressed in dADL or an XML equivalent, and would list the 'configuration' of concrete artefact revisions used to generate the operational version.

The structure of a Configuration is as follows:

TBD_6: convert following to UML

```
configuration: archetype_config template_config subset_config lineage_config
    rm_release
archetype_config: { config_item }+
template_config: { config_item }*
subset_config: { config_item }*
rm_release: rm_name release_id
lineage_config: { lineage_item }*

config_item: identifier [ revision_id [ commit_id ] ] [ signature ]
lineage_item: archetype_id { archetype_id }+

signature: CHARACTER_SEQUENCE
revision_id: V_INTEGER
commit_id: V_INTEGER
release_id: V_STRING
```

An example of the configuration of an operational template in a controlled environment (dADL format) is as follows:

```
configuration = <
    archetypes = <
        [1] = <
            id = <"org.openehr.ehr::openEHR-EHR-OBSERVATION.heartrate.v1">
            revision = <"3">
            commit = <"28">
            signature = <"23895yw85y0y0">
        >
        [2] = <
            id = <"se.skl.epj::openEHR-EHR-EVALUATION.genetic-diagnosis.v1">
            revision = <"2">
            commit = <"0">
            signature = <"98typrhweruhfd">
        >
        [3] = <
            id = <"org.openehr.ehr::openEHR-EHR-EVALUATION.problem.v2.4">
            revision = <"5">
            commit = <"0">
            signature = <"2rfhweiudfwieurfh">
        >
    >
    templates = <
        [1] = <
            id = <"se.skl.epj::openEHR-EHR-COMPOSITION.vital_signs.v5">
            revision = <"36">
            commit = <"0">
        >
    >
    subsets = <
        [1] = <
            id = <"org.ihtsdo.general::cardiac_diagnoses.v18">
            revision = <"1">
            commit = <"0">
```

```
         >
      >
      lineages = <
         ["se.skl.epj::openEHR-EHR-EVALUATION.genetic-diagnosis.v1"] = <
            "org.openehr.clinical::openEHR-EHR-EVALUATION.diagnosis.v1",
            "org.openehr.clinical::openEHR-EHR-EVALUATION.problem.v2"
         >
      >
      rm = <
         name = <"openehr">
         release = <"1.1">
      >
   >
```

5.3 References from Data

5.3.1 Requirements

In knowledge-enabled information environments such as those built on the *open*EHR principles, knowledge artefacts are used to control the creation and validation of data, with the effect that data eventually stored in such systems 'conform' to the relevant artefacts. In order to be able to further process (e.g. display, modify and query) such data, references of some kind to the knowledge artefacts must be stored in the data. The requirements for such references depend on where the data are found, broadly within two possible situations, namely data within operational systems (e.g. EHR systems) and data within 'messages', 'extracts', or 'documents' sent between systems.

Three requirements can be identified with respect to data within systems.

Reconstitutability: firstly, it must be possible to re-connect data with the archetypes, templates and subsets, in their specific revisions, used to create them.

Querying: secondly, it must be possible to know what archetypes (down to the revision), and therefore what path-sets can be used for querying data - given that this may well include parents of specialised archteypes, not just the archetypes used to directly create the data.

Optimisation: we can also assume that in a typical production system handling millions of health records, that the size of artefect identifiers embedded in data (especially if repeated) may be an issue, and that some kind of space optimisation may be required.

Within extracts or messages, the same requirements broadly hold, but could be better restated as follows.

Reconstitutability: it must be possible for the receiving system to be able to determine the relationship of each data element with the artefacts(s) used to create it, so that it can be correctly reconstituted in the receiver system environment.

Querying: for ensuring the correct functioning of querying, the extract or message should potentially carry sufficient archetype lineage information the archetypes used in the data to allow querying at the receiver, particularly if the latter wants to be able to query using more general parents (e.g. a 'problem' archetype rather than some specific diagnosis specialisation).

Optimisation: a reasonable trade-off between space optimisation and clarity of representation must be used, given that messages, extracts etc flow between heterogeneous systems.

5.3.2 Reconstitutability

The reconstitutability requirement means recording archetype and template identifiers on the relevant nodes in the data. A basic form of this has always been defined in *open*EHR, such that at archetype root nodes, the archetype identifier and if relevant the template identifier is recorded, and at interior nodes, the at-codes are recorded (formally, the archetype identifier and at-codes are recorded in the LOCATABLE.*archetype_node_id* attribute of each data node). In data created based on *open*EHR Releases 1.0.2 or earlier, the archetype identifier references are of the form:

```
openEHR-EHR-EVALUATION.diagnosis.v1
```

With the more sophisticated identification system described here, these archetype references need to include namespace, revision and commit number. This leads to references of the form:

```
org.openehr.ehr::openEHR-EHR-EVALUATION.diagnosis.v1.29.0
```

References with no namespace will remain legal, since there should be no computational impediment to using uncontrolled archetypes and templates, e.g. in an experimental situation. The lack of revision and commit number should also be legal, and be interpreted as meaning '0' in both cases, i.e. '.v1' means '.v1.0.0'.

5.3.3 Supporting Querying

Querying of data in *open*EHR systems is assumed to be based on archetype 'path-sets', i.e. the set of paths extracted from an operational (flat-form) archetype. The paths are a slight simplification of standard X-paths. Two querying methods have been described to date, AQL and a-path, both making this assumption (see openEHR wiki).

Based on this assumption, given an archetype X used to create data, the following archetypes could be used for querying:

- the same archetype, i.e. exact same version, revision & commit;
- any previous revision of the same archetype;
- any of the specialisation parents of the archetype;
- any previous revision of any of the specialisation parents of the archetype.

For non-specialised archetypes, the allowable querying archetypes can be deduced from the archetype reference recorded in the data. For specialised archetypes, the specialisation lineage can only be obtained from the operational form of the archetype, found in the template used to create the data. This would create a potential problem where for data imported from another site without the relevant template(s), the archetype lineage information was not available. This would prevent the query engine at the receiver system knowing how to query the data using even the more general archetypes in the lineage, that it may have access to.

To address this situation, it may be useful to include the configuration meta-data from the operational template(s) with the data when it is transferred outside of its normal environment, e.g. in an EHR Extract.

The other possibility is to include archetype lineage information in the data itself. This could be a modified form of the identifier reference in the case of specialised archetypes to allow lineage information to be stored. The simplest form of this would be as a list of operational identifiers, e.g.

```
se.skl.epj::openEHR-EHR-EVALUATION.genetic_diagnosis.v1.12,
org.openehr.ehr::openEHR-EHR-EVALUATION.diagnosis.v1.29,
org.openehr.ehr::openEHR-EHR-EVALUATION.problem.v2.4
```

5.3.4 Formal Model

A form of reference catering to the above requirements is as follows:

```
archetype_data_ref: archetype_id_ref { ',' archteype_id_ref }*
archetype_id_ref: source_qualified_id '.' revision_id '.' commit_id
    | uncontrolled_id
```

5.3.5 Optimisations

In normal archetype-based data, both basic references and additional lineage information might be repeated throughout a given component, such as an *open*EHR or ISO 13606 COMPOSITION. Consider a COMPOSITION documenting problems & diagnoses of the patient, where each problem is recorded using the archetype

```
uk.nhs.royalfree.clinical::openEHR-EHR-EVALUATION.diagnosis.v2.15.0
```

whose lineage is:

```
org.openehr.ehr::openEHR-EHR-EVALUATION.diagnosis.v1.29.0
org.openehr.ehr::openEHR-EHR-EVALUATION.problem.v2.4.0
```

In this example, the archetype reference lengths are 66, 57 and 54 characters respectively, i.e. a total of 177 characters. Repeated say 5 times would give 885 characters of identifier meta-data for the COMPOSITION, whose main clinical data could easily be significantly less. Even in an XML-based storage system, various kinds of compression are used, the identifier reference overhead could become a significant fraction of the overall data storage requirement. It is therefore worth considering various simple optimisations, while retaining clarity and comprehensibility in the data.

The most obvious optimisation is to use a set of variable references local to the data context, in this case an *open*EHR or ISO 13606 Composition. For example, at the top of the Composition, the following definitions could be made:

```
ar01=uk.nhs.royalfree.clinical::openEHR-EHR-EVALUATION.diagnosis.v2.15.0,
    org.openehr.ehr::openEHR-EHR-EVALUATION.diagnosis.v1.29.0,
    org.openehr.ehr::openEHR-EHR-EVALUATION.problem.v2.4.0
ar02=se.skl.epj::openEHR-EHR-OBSERVATION.hba1c_result.v1.4,
    org.openehr.ehr::openEHR-EHR-OBSERVATION.lab_result.v1.18
etc
```

The identifiers 'ar01', 'ar02' etc would then be used in the data, reducing the indentifier overhead by nearly 80% for the above example. This possibility would be enabled by adding an attribute to contain the variable definitions at the top of the COMPOSITION type in the *open*EHR Reference Model, and in equivalent classes in other models.

The use of such variables will somewhat complicate querying and other data processing, since a query that returns part of a Composition would return data containing meaningless local variable names rather than proper archetype meta-data.

A second question to consider is whether any parts of the identifiers could be removed. For example, it might initially appear that the reference model and class identification could be removed altogether, since the data when initially create would seem by definition to be based on the reference model and class of the archetype. However, neither are guaranteed. Consider the following two cases which use archetypes based on a different reference model to create data:

- a data extractor that transforms source data, say in *open*EHR form, to a standard form, say in ISO 13606 form. The archetype identifiers embedded in the latter data will be the original *open*EHR archetype identifiers (the extractor does not create new archetypes to do its transformation work);

- a product that is directly based on another standard, such as ISO 13606 but uses the published library of *open*EHR archetypes.

Similarly, in the case of the class, the data may easily be based on a descendant (e.g. the `POINT_EVENT` class in *open*EHR) of the class mentioned in the archetype (e.g. `EVENT`).

We therefore assume that although some of the above assumptions might be available in very particular environments, they cannot be safely made in general, particularly since it can never be predicted where data may be shared.

5.3.5.1 Reference Compression

Nevertheless, it would be possible to go further in terms of removing repetition in the once-only declarations. For instance, a compressed form of the archetype lineage information could be constructed, whereby repeated sections in each subsequent identifier are replaced by a special character. The example above would become:

```
ar01=uk.nhs.royalfree.clinical::openEHR-EHR-EVALUATION.diagnosis.v2.15.0,
     org.openehr.ehr::~.diagnosis.v1.29.0,
     ~::~.problem.v2.4.0
ar02=se.skl.epj::openEHR-EHR-OBSERVATION.hba1c_result.v1.4,
     org.openehr.ehr::~.lab_result.v1.18
```

The above syntax uses the '~' character in each identifier in the list to mean 'the missing parts are taken from the corresponding element(s) of the previous identifier in the list' (the inspiration is the use of the '~' in dictionaries to stand for the keyword). In this syntax, the concrete archetype used to create the data is guaranteed to appear first and in its entirety in the list.

In this reference, it is assumed that revision and commit numbers are meaningless for uncontrolled artefacts.

Clearly in a particular system in which archetypes were only ever used from the same reference model as the system itself is built on, an even further reduced form of these references could be created. However, if the data were ever to be shared, such references would be in danger of being non-interoperable.

Whether the additional saving in space justifies the added complexity in parsing is debatable.

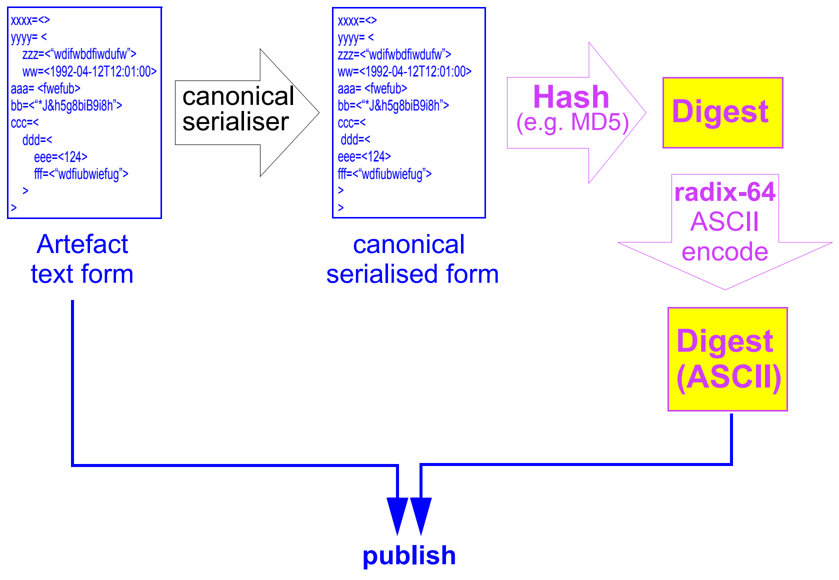
6 Artefact Authentication

In theory, revision information should be reliable, and no two physical knowledge artefacts should exist that are either identical but have different identifiers and/or revision information, or are different but are identified as being the same. However, in practical systems, such situations can occur due to uncontrolled artefact creation, uncontrolled copying, and errors in version management.

6.1 Integrity Check

It is therefore useful to be able to determine whether two artefacts (usually purported copies or subsequent revisions) are the same or not, regardless of revision information. This can be achieved by the use of a digital hash function (e.g. SHA-1, MD5), which generates a 'fingerprint' of the artefact. Two archetypes with the same hash value must be the same – hash functions generate a different result if even a single bit is different in the input stream. However, applying such functions to the typical file representation of an archetype or template will not usually have the desired result. This is because differences in white-space and non-significant ordering, which make no difference to the semantics – will still generate different hash values. Other semantically insignificant differences include changes to meta-data values, such as descriptions, etc may have been changed (e.g. to correct spelling, improving wording), and changes or additions to translations.

As a consequence, the input to a hashing function for the purpose of generating a semantic signature of an *open*EHR knowledge artefact must be some canonical form of the original literal artefact, that is impervious to differences of the above types while retaining differences that will affect computation with such artefacts. The integrity check process is illustrated below.



```
xxxx=<>
yyyy= <
   zzz=<“wdifwbdfiwdufw”>
   ww=<1992-04-12T12:01:00>
aaa= <fwefub>
bb=<“*J&h5g8biB9i8h”>
ccc=<
   ddd=<
      eee=<124>
      fff=<“wdfiubwiefug”>
   >
>
```

```
xxxx=<>
yyyy= <
zzz=<“wdifwbdfiwdufw”>
ww=<1992-04-12T12:01:00>
aaa= <fwefub>
bb=<“*J&h5g8biB9i8h”>
ccc=<
 ddd=<
eee=<124>
fff=<“wdfiubwiefug”>
>
>
```

FIGURE 3 Integrity check applied to knowledge artefact

6.2 Authentication

A second need to do with validity of knowledge artefacts is establishing their authenticity, i.e. their true origin. The usual way of supporting authentication is with a digital signature. A typical scheme based on the public key infrastructure (PKI) concept is for the producer of an artefact to sign it with their private key, and for the public key to be used by a consumer of the artefact to decrypt the signed entity.

In the case of *open*EHR knowledge artefacts, the need is to know the originating Publishing Organisation of an artefact. The PKI approach is for each PO to generate a key pair, and to provide the public key to the Central Governance Authority. Signing is then carried out using the PO private key on the hash digest already generated for an artefact. The modified process is illustrated in FIGURE 4.

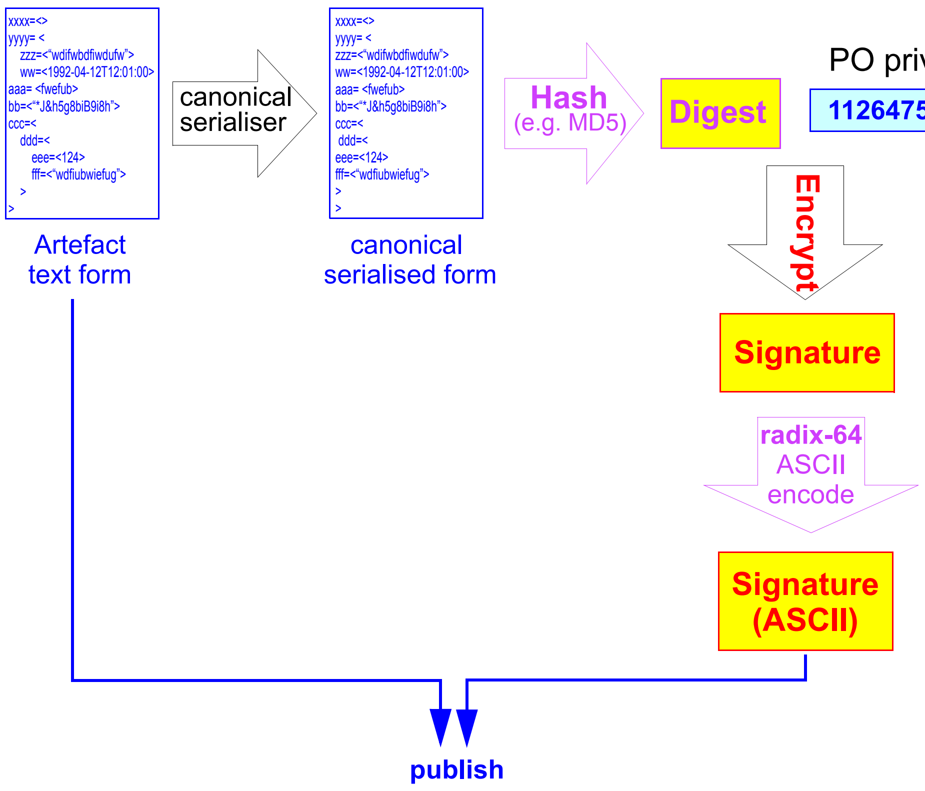


FIGURE 4 Digital signature check applied to knowledge artefact

6.3 Canonical Form – Archetype 'semantic view'

For hashing and signing to be useful, the input artefacts need to have two characteristics. Firstly, we need to know that the artefact has been validated, since there is no use in disseminating digitally authenticated but useless artefacts. Secondly, the effects of 'non-semantic' changes in the artefact must be removed. This requires a syntactic canonical form.

Both requirements can be achieved for archetypes and templates with a canonical form based on a 'semantic view' of an archetype, analagous to the 'interface class' idea in software development. The semantic view is created from a specific serialisation of the abstract syntax tree (AST) form of the artefact, which is its computable form. The full AST form is in fact defined by the *open*EHR AOM, but this contains all textual meta-data from the description, ontology and other sections of the archetype. The 'semantic' form of this model, suitable for generating a normalised serialisation for hashing has the following reduced form:

- the identifier;
- specialisation identifier, where present;
- concept code;

- definition section (comments stripped).

These objects would be represented in the same form as defined by the AOM. A suitable serialisation is the dADL syntax form. XML forms could be used, but they depend on which schema variant is in use, and there is no single normative *open*EHR XML-schema for the AOM.

TBD_7: canonical forms of other artefact types

END OF DOCUMENT