2.2. Implementation Types

SNOMED CT itself is only a part of the solution to addressing the requirements for effective electronic clinical records. A terminology on its own "does" nothing unless it is implemented as part of an application and used. Implementation of SNOMED CT requires software applications that exploit its features to meet the real and perceived needs of users.

The "users" of SNOMED CT include:

- Those who specify, commission and configure software for use in a particular clinical environment;
- End-users who enter or retrieve clinical information.

As illustrated by , users experience SNOMED CT through application software which delivers services to access and apply SNOMED CT. The ways in which applications apply the features of SNOMED CT to address user requirements determine the extent to which the potential benefits are realized .

The following sections summarize some of the types of implementation that may be needed to meet different requirements. Some types of application do not need to support or use all SNOMED CT features. However, there are some overarching requirements for consistency between implementation used within a given organization, country or region. Even where requirements are limited, care should be taken to ensure that SNOMED CT enabled applications are aligned with good practice and with agreed policies applicable to the situations in which they are used.

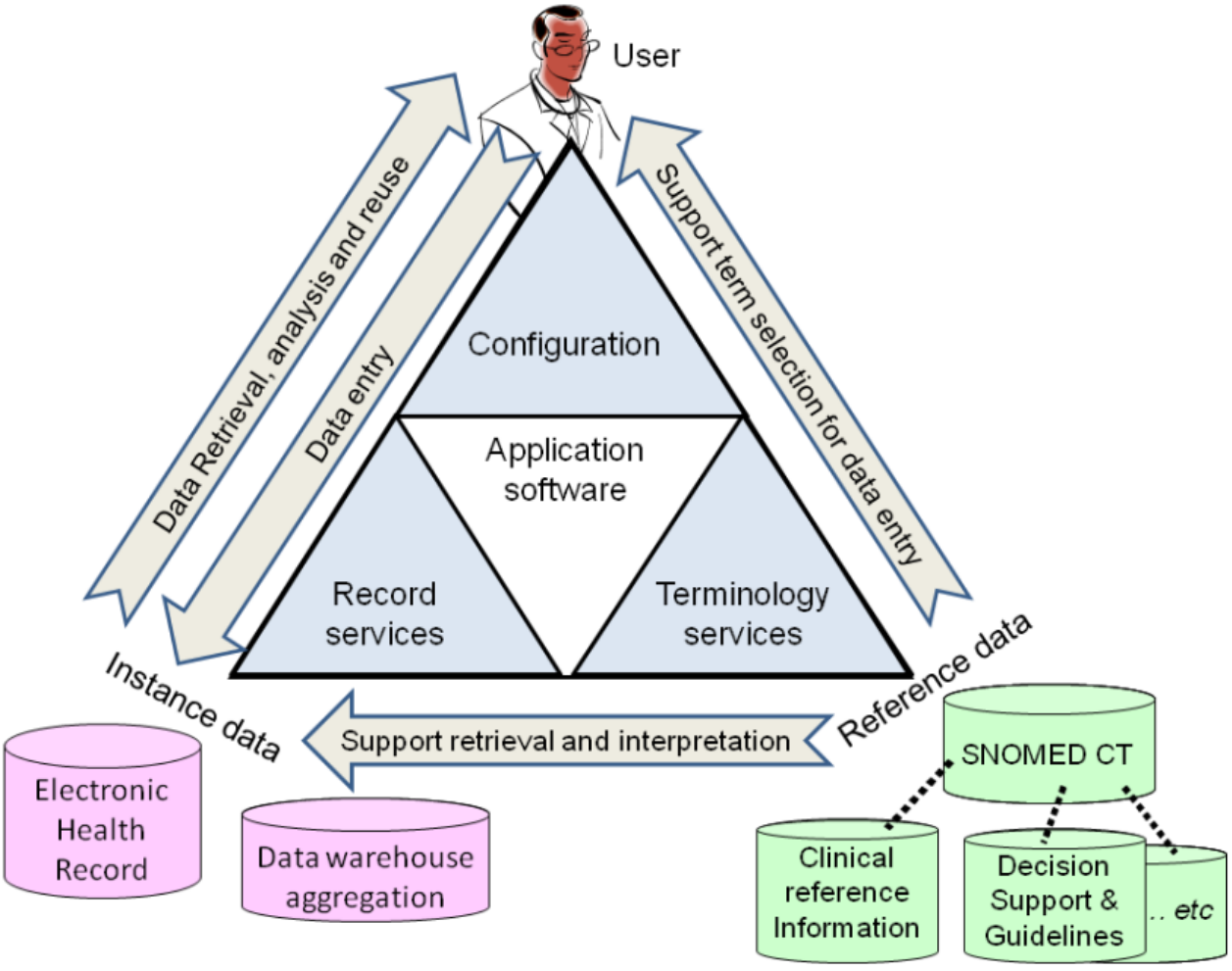

Figure 2.2-1: Relationship between users application software and SNOMED CT

Implementation Types - Clinical records

A SNOMED CT enabled clinical record application uses SNOMED CT expressions to represent clinical information in the records of individual patients.

Clinical record applications include specialized departmental systems, organization -wide systems and systems that integrate multiple systems to deliver a distributed electronic health record or a collection of widely accessible summary records.

A SNOMED CT enabled clinical record application needs to provide record services including entry, storage, retrieval and communication of SNOMED CT expressions. These record services depend on terminology services including the ability to search for concepts and to interpret stored SNOMED CT expressions .

A wide range of types of information can be represented at different levels of detail using SNOMED CT expressions. The types of information and level of detail that are used may vary depending on user requirement or may be limited by the design of the application. Differences in the required level of expressivity influence the range of record services that need to be supported.

The way that SNOMED CT expressions are represented within a record structure affects the range of services that are required to deliver the potential benefits of implementation. The value of the rich expressivity of SNOMED CT may be enhanced or diminished by the way the record structure relates SNOMED CT expressions to surrounding contextual information. For example, if a record structure permits similar or related information to be recorded in several ways a query to retrieve that information will need to consider all these possibilities. Retrieval is simpler if similar information is recorded in a consistent way - irrespective of the way it was entered. This issues are discussed in detail in the Record Services Guide .

Related Links

- 4.3.4. Representational forms for expressions
- 4.2.2. SNOMED CT Expressions - Logical Model
- 8.2. Storing Expressions

Implementation Types - Knowledge representation

A SNOMED CT enabled knowledge representation uses SNOMED CT expressions to represent or tag resources that represent clinical knowledge. Examples of resources that can be SNOMED CT enabled include electronic reference books, clinical guidelines, care pathways, decision support protocols and requirements for analysis and audit.

There are various ways in which SNOMED CT expressions can be used in a knowledge resource. These can be divided into two broad categories:

- Use of SNOMED CT expressions as an integral part of a structured representation of knowledge:
  - For example, a decision support rule that tests for the existence of a record of a particular type of finding represented using a SNOMED CT expression .
- Use of SNOMED CT expressions to tag or index a knowledge resource:
  - For example, a reference book in which textual descriptions of indications, contraindications and side effects of particular treatments are tagged with SNOMED CT expression that can be used to allow context-sensitive retrieval of relevant information.

There are two distinct but interrelated aspects to SNOMED CT knowledge representation.

- Applying SNOMED CT expressions to the resource:
  - The form of representation to be used must be specified in a way that takes account of the ways in which the resource is to be used and accessed.
  - The knowledge authoring environment must allow the specified representation to be applied consistently. This requires use of Terminology services that allow searching and selection of concepts. Depending on the level of detail required, there may also be a requirement to support the construction of postcoordinated expressions .
- Enabling appropriate access to and use of the resource:
  - The types of access required depend on the intended functionality.
  - The most basic level of functionality involves using SNOMED CT expressions as a concept -based index. By taking account of the SNOMED CT subtype hierarchy and defining relationships, a concept -based index can provide more relevant results than a simple term based search.
  - More sophisticated uses such as clinical decision support require SNOMED CT expressions in the knowledge resource to be used to generate queries that can be applied to information stored in an electronic health record .
  - The provider of a SNOMED CT enabled knowledge resource may provide a specification that allows software developed by other organizations to interrogate it and provide the required level of functionality. Alternatively, the knowledge authoring organization may also develop and provide software that delivers the intended functionality.

Implementation Types - Aggregation and analysis

SNOMED CT enabled aggregation and analysis systems use SNOMED CT to enable effective aggregation and analysis of information derived from clinical record systems.

SNOMED CT enables consistent processable representation of clinical information. As well as presenting opportunities for analysis of information within an individual clinical record system, this can be used to support analysis of a broader substrate of aggregated data.

There are two types of approach that be employed to enable analysis of aggregate data.

- A SNOMED CT enabled data warehouse:
  - The content and structure of data required from individual Clinical Information Systems is specified. The specified structure must include details of the required representation of data including SNOMED CT expressions .
  - The required data is extracted and uploaded to a database designed for the purpose of large scale analysis. Usually the extract and upload will need to be repeated or updated at specified intervals.
  - The central database is structured to optimize common types of queries taking account of the SNOMED CT expressions and the relationships between referenced concepts asserted in SNOMED CT content.

        - A query interface is provided to allow common types of question to be expressed against the central database.
        - Queries are run taking account of the relationships between concepts to provide comprehensive and accurate results (minimizing the risks of false negatives or false positives).
        - The results of queries are presented where relevant using SNOMED CT expressions as processable labels to enable further analysis.
- A common query specification supported by clinical record systems:
    - A common reference information model including SNOMED CT expressions is specified. This is used as a common model of meaning against which queries are evaluated.
    - Each clinical record system provider implements this common model of meaning as a *view* of the information stored in their electronic health record .
    - A query interface is provided to allow common types of question to be expressed against the common model of meaning .
    - Queries are distributed and run on individual systems and the results are returned to a central system for aggregate reporting.
    - The results of queries are presented where relevant using SNOMED CT expressions as processable labels to enable further analysis.

In practice, there is significant overlap between these two approaches. A data warehouse approach can benefit from a common approach to specifying the information extraction requirements. This allows changes to the specification without re-engineering the contributing clinical record systems. A common query specification approach requires a central element to manage distribution of queries and aggregation of results.

Irrespective of the approach taken, SNOMED CT enabled aggregation and analysis is most effective where the representation of information in the contributing clinical record systems is consistent with a common view. However, it is possible to aggregate information from diverse systems if the limits imposed by differences are understood. It is even possible for a SNOMED CT aggregation and analysis system to be applied information that was not originally encoded using SNOMED CT. An extraction and aggregation interface that includes mapping from another coding system may produce information of adequate quality and consistency for many purposes. Data derived by tagging textual records using natural language processing may also meet requirements that are not safety-critical.

Terminology tools

SNOMED CT enabled terminology tools provide access to SNOMED CT content. On their own they are not practical end-user implementations but they enable the development and review of SNOMED CT . They may also deliver services that can be used by end-user implementations.

Implementation Types - Terminology browser

A SNOMED CT enabled browser allows the content and structure of SNOMED CT to be explored and reviewed.

A typical SNOMED CT enabled browser can locate concepts and descriptions by Identifiers and by searching the text of description term. Various views of located concepts may be displayed including the set of related descriptions, the hierarchical relationships and other defining relationships .

A terminology browser may be:

- A stand-alone tool.
- Part of a more extensive implementation.
- Accessible via an Application Programming Interface (API):
    - This may allow the browser to be used by client applications to select SNOMED CT expressions ;
    - It may be part of a terminology server which provides a wider range of Terminology services .

Implementation Types - Terminology server

A SNOMED CT enabled terminology server is a software application that provides programmatic access to SNOMED CT components. These services are made available through a documented Application Programming Interface (API) which can be used by many different client applications.

A SNOMED CT enabled terminology server must be able to import SNOMED CT release files and provide some or all of the services described in the Terminology Services Guide. All terminology servers must support a basic minimum set of functions including Foundation Terminology Services and access to Reference sets and other metadata .

A terminology server may provide user interface services, such as a set of screen controls to support term selection. Alternatively, while the API should support searches, the user interface representation of the results of a search may be left to client applications. Where user interface controls are provided by the server, these controls may also be packaged in an integrated form as a terminology browser .

A SNOMED CT enabled terminology server may also provide services that support the use of other terminologies. In this case, it may conform to a standard specification such as Common Terminology Services 2 (CTS2).

Implementation Types - Terminology development and maintenance tools

SNOMED CT development and maintenance requires tools which are able to create and update SNOMED CT content.

Development and maintenance tools may either be general purpose or may focus on specific requirements (e.g. Reference Sets to support language, mapping or development of value sets).

The process of maintenance needs to track changes and manage conflicts between edits made by different authors. In the case of content development, the tools must also ensure that concept definitions conform to the SNOMED CT Concept Model. At regular intervals the tools need to generate a consistent set of quality assured release files .

The IHTSDO Workbench is a set of software tools designed to support the development, maintenance, and use of SNOMED CT. Its key role is to facilitate the maintenance of the SNOMED CT International Release and the National Extensions developed by Members. However, the future scope of use may extend to other organizations and to health information systems around the world. The Workbench is owned by the SNOMED International and is available under an Open Source license agreement.