

2.3. Implementation Levels

SNOMED CT can be implemented in a wide range of clinical record applications. These include systems developed for use with other code systems that have been adapted to support **SNOMED CT** as well as systems designed with the assumption that **SNOMED CT** would serve as the primary terminology. The **SNOMED CT** features that applications support and use may vary, partly due to differences in user requirements and partly due to development priorities. Against this background of variability, it is reasonable to ask what is a **SNOMED CT implementation** or what is a good **SNOMED CT implementation**. While there is not a single or simple answer to these questions, this section identifies some key dimensions which determine the capability of **SNOMED CT** enabled clinical record systems.

Each of the following sections describes a dimension and outlines a spectrum of capabilities ranging from absence of support (Level 0) to full support (Level 2). A mixture of Level 0 and Level 1 capabilities are likely to be found in existing systems that have been adapted to work with **SNOMED CT**. A system specifically developed to work with **SNOMED CT** should be expected to have capabilities that are at least at the high end of the Level 1 spectrum and should ideally have Level 2 capabilities.

The specification of different levels is not intended to suggest a step-by-step development path. Those needing to rapidly **SNOMED CT** enable an existing clinical record system are recommended to follow a two stage approach.

1. Design, develop and deploy a revision to the current system to support Level 1 capabilities that meet known short or medium term requirements:
 - The level achieved in this stage will depend on customer requirements and the design limitation of the existing system.
2. Design and develop a new or substantially revised system (including revised record structures) to support a mixture of high-end Level 1 and Level 2 capabilities:
 - The level at which this development is target should be one that meets anticipated medium to long term requirements;
 - Even if the initial target of the work is limited to the high-end of Level 1, the design should be sufficiently flexible to enable Level 2 capabilities to be added when required.

Developers who do not require a rapid deployment based on a revision of an existing systems are recommended to skip the first step and proceed to design and develop a flexible solution that utilizes the key strengths of **SNOMED CT**.

Each of the following sections describes one dimension that contributes to the overall implementation level. It is important to recognize that:

- This is not a formal scoring scheme:
 - Some dimensions are more significant than others;
 - The significance of reaching a particular level depends on the nature of the application and the user requirements it seeks to address.
- Many of the dimensions are inherently interdependent:
 - For example, Level 2 data entry capabilities are not compatible with Level 1 data storage.

Implementation Level - Scope of use

A clinical record system may use **SNOMED CT expressions** to represent some or all of the types of information outlined in the list below. The types of information for which **SNOMED CT** can be used may be limited by the structure used to store the **electronic health record**. The significance of these limitations depends upon the intended use of the clinical record system.

- Level 0: No support for **SNOMED CT expressions**.
- Level 1: Support for use of **SNOMED CT** limited to particular types of clinical data:
 - Addressing the requirements for a particular type of use;
 - Addressing a set of requirements specified by a particular organization.
- Level 2: Support for consistent use of **SNOMED CT** across a broad scope of information types:
 - Providing a general purpose approach to the use of **SNOMED CT** within an **electronic health record**
 - Allowing configuration to vary the scope of coverage to meet specific requirements.

The following check-list identifies some of the **electronic health record** elements in which **SNOMED CT expressions** might be used. The list is not complete but it covers many of the areas in which use of **SNOMED CT** has been discussed in **SNOMED International** working groups. It is intended to assist consideration of the areas in which **SNOMED CT** should be used to meet the needs of users and organizations. The inclusion of an item in this list does not imply that the **SNOMED CT International Release** provides comprehensive content to populate that part of the record.

1. Disorders, diagnoses and problems:
 - Problem list entries;
 - Admission diagnosis;
 - Discharge diagnosis;
 - Provisional or working diagnosis;
 - Differential diagnosis.
2. Symptoms:
 - Presenting symptoms;
 - History of current condition;
 - Other symptoms.
3. Allergies and adverse reactions:
 - Adverse reaction events;
 - Allergies and other propensities to adverse reactions.
4. Procedures:
 - Operative procedures.
 - Diagnostic procedures.
 - Medications:

- Current medication;
 - Prescriptions;
 - Dispensing records;
 - Drug charts.
 - Other therapeutic procedures:
 - Other therapy requests;
 - Other therapy delivery and outcomes.
5. History:
- Medical and surgical past history;
 - Medication history;
 - Family history.
6. Examination findings:
- Vital signs;
 - Clinical examination findings.
7. Investigation information:
- Laboratory investigations:
 - Laboratory investigation requests;
 - Laboratory investigation procedures;
 - Laboratory investigation results.
 - Diagnostic imaging:
 - Diagnostic imaging requests;
 - Diagnostic imaging procedures;
 - Diagnostic imaging results.
 - Other investigations:
 - Other investigation requests;
 - Other investigation procedures;
 - Other investigation result.
8. Other types of clinical information:
- Planned actions;
 - Risk, goal and expected outcomes;
 - Scale based assessments;
 - Progress notes.
9. Administrative information:
- Admission, transfer and discharge events.
10. Other values:
- Body sites, structures and locations;
 - Organisms;
 - Substances (other than drugs);
 - Pharmaceutical and biological products (drugs).

Implementation Level - Record structure

The logical model underlying the structure of the record has a direct effect on the ability of a [SNOMED CT](#) enabled clinical record system to take advantage of the features of [SNOMED CT](#). An application may use an optimized proprietary internal representation of the [electronic health record](#). However, consistent use of [SNOMED CT](#) across a range of applications requires a common reference model to which proprietary structures are mapped. In addition to this, the ways in which [SNOMED CT expressions](#) are used within a common [reference information model](#) need to be constrained to improve predictability and minimize ambiguity.

- Level 0: A proprietary structure that is neither aligned with nor mapped to a standard [reference information model](#):
 - Low: Text only record with no use of clinical codes;
 - High: Structured record supporting use of clinical codes.
- Level 1: A structure that is aligned with or mapped to a standard [reference information model](#):
 - Low: Proprietary structure mapped to a standard model to support limited messaging requirements. Supports the use of [SNOMED CT](#) coding within that structure.
 - High: Structure aligned with a standard [reference information model](#) that supports that supports use of [SNOMED CT](#) coding.
 - Examples of standard [reference information models](#) include:
 - The [HL7 Version 3 Reference Information Model \(RIM\)](#);
 - The [CEN TC251 Health informatics - Electronic health record communication - Part 1: Reference model \(EN13606\)](#) .
- Level 2: An aligned or mapped structure in which [SNOMED CT expressions](#) are used in accordance with agreed guidelines for use of a standard [reference information model](#):
 - In Level 2 [SNOMED CT](#) is used in accordance with [terminology binding](#) guidance to minimize the semantic gaps and overlaps between the terminology and the information model. Without constraints, these gaps and overlaps lead to inconsistent representation of similar data and thus limit the effective reuse of information.
 - Example of agreed guidelines for using use of [SNOMED CT expression](#) in particular reference models include:
 - The [HL7TermInfo DSTU - Guide to the Use of SNOMED CT in HL7 Version 3](#);
 - Guidance on [terminology binding](#) developed by the [UK NHS Logical Record Architecture](#) for use in an [EN13606](#) based logical model.

Implementation Level - Expression storage

Support for storing [precoordinated](#) and [postcoordinated SNOMED CT expressions](#) determines the extent to which [SNOMED CT](#) can be used to represent detailed information within an [electronic health record](#) .

- Level 0: No support for storage of [SNOMED CT expressions](#)
- Level 1: Support for storage of [precoordinated SNOMED CT expressions](#):
 - Support for storage of a [precoordinated expression](#) implies the ability to store a representation of a [concept identifier](#) as part of each item for which [SNOMED CT](#) is used:
 - The [concept identifier](#) may be represented as a 64-bit [Integer](#) or as an 18-digit [string](#) ;
 - Other internal representations may be used provided they can be resolved to the appropriate [Identifier](#) for display, communication or processing.
- Level 2: Support for storage of [postcoordinated SNOMED CT expressions](#):
 - Support for storage of [postcoordinated expression](#) implies the ability to store a representation that captures the logical model of a [postcoordinated expression](#):
 - The simplest representation of a [postcoordinated expression](#) is the [SNOMED CT compositional grammar](#). Due to the open-ended nature of [postcoordinated expressions](#) , this representation results in a string of variable length with no clear-cut maximum length.
 - The guide discusses alternative representations including the use of [expression](#) reference table which enables use of a fixed length reference within the records. This approach uses a [UUID](#) which can be represented as a 128-bit [Integer](#) or as a hexadecimal [string](#) (see [Storing expressions](#)) .
 - This level has variants depending on the extent of support for [postcoordinated expression](#) storage:
 - Low: Storage of [postcoordinated expressions](#) limited to specific fields in the record structure;
 - High: Full support for storage of [postcoordinated expression](#) allowing any valid [expression](#) to be stored and retrieved.

Implementation Level - Data entry

The categorization in this section is based on the extent to which the system enables entry of [SNOMED CT expressions](#) . In addition, this section indicates the importance of a well-designed user-interface.

- Level 0: No support for entry of [SNOMED CT expressions](#) .
- Level 1: Support for [precoordinated SNOMED CT expression](#) entry:
 - Low: Access limited to fixed set of [SNOMED CT concepts](#) ;
 - Medium: Access to full content of [SNOMED CT](#) ;
 - High: Access to full content of [SNOMED CT](#) with configurable [value sets](#) matched to user requirements.
- Level 2: Support for [postcoordinated expression](#) entry:
 - Low: Access to limited [postcoordination](#) (matching data storage restrictions);
 - Medium: Access to full range of [postcoordination](#) supported by the [Concept Model](#) ;
 - High: Access to [postcoordination](#) with configurable [constraint](#) matched to user requirements.

Another important data entry issue is the ease of use which depends on the usability, relevance and performance of searches. Where [postcoordinated](#) data entry is supported the approach to selecting or constructing [postcoordinated expressions](#) is also significant.

An attempt to categorize specific approaches to the user-interface is subjective as alternative [user interfaces](#) may be appropriate to different uses. However, for most environments a flexible range of configurable [SNOMED CT](#) aware user-interface tools is likely to offer a better user experience than reliance on a one-size fits all [browser](#) or search engine.

Implementation Level - Data retrieval

A major strength of [SNOMED CT](#) is its ability to support meaning based selective retrieval. The extent to which this feature is used by a clinical record system determines the value of entering and storing the data.

- Level 0: No native support for [SNOMED CT](#) enabled data retrieval:
 - This level has variants depending on whether it can map code in exported data to [SNOMED CT expressions](#):
 - Low: No support for [SNOMED CT](#) based analysis;
 - High: Support for extracting a specified set of locally coded data and mapping the local codes to appropriate [SNOMED CT expression](#) for central aggregation and analysis.
- Level 1: Support for retrieval of [precoordinated SNOMED CT expressions](#):
 - This level has a spectrum of variants depending on the level of support for the following features:
 - [Query](#) expressivity: The ability to express [query](#) predicates that explicitly include or exclude [subtypes](#) of specifically identified [concepts](#) ;
 - Subsumption testing: Use of [SNOMED CT subtype hierarchy](#) to interpret and evaluate queries;
 - [Concept Equivalence](#) : The ability to retrieve equivalent information even if it is represented in different structures within the record;
 - Context awareness: The ability to take account of contextual information, derived from the record structure and/or the [SNO MED expression](#) , when interpreting and evaluating queries;
 - Performance: The ability to interpret and evaluate queries within an appropriate period of time and without causing deterioration in other system functions.
- Level 2: Support for retrieval of [postcoordinated SNOMED CT expressions](#):
 - This level has a spectrum of variants depending on the level of support for the following additional aspects of the features specified for Level 1:
 - [Query](#) expressivity: The ability to represent [postcoordinated](#) predicates in a [query](#) ;
 - Subsumption testing: Use of [defining characteristics](#) and [normal form transformations](#) (or a [description logic classifier](#)) to determine whether [expressions](#) are subsumed by [query](#) predicates;

- **Equivalence:** Use of [defining characteristics](#) and [normal form transformations](#) (or a [description logic classifier](#)) to determine [equivalence](#) between different [postcoordinated expressions](#) and in different structures within the record;
- **Context awareness:** The ability to take account of contextual information derived from the record structure and/or [postcoordinated SNOMED expressions](#) , when interpreting and evaluating queries;
- **Performance:** The ability to interpret and evaluate queries that support [postcoordinated](#) representations within an appropriate period of time and without causing deterioration in other system functions.

Implementation Level - Communication

The ability to send and received [SNOMED CT expressions](#) in messages or other communication is partially dependent on data entry, storage and retrieval capabilities. However, some types of communication may be supported by mapping or human-readable renderings even in the absence of internal support for [SNOMED CT](#) .

- **Level 0: Mapping based support for communication of [SNOMED CT expressions](#):**
 - **Inbound communications containing [SNOMED CT expressions](#):**
 - Low: Not supported.
 - Medium: Rendered as human-readable text. Unless the inbound message also contains the [term](#) text, this requires access to some [SNOMED CT](#) enable [Terminology services](#) to lookup and display the relevant [term](#) .
 - High: Mapped to an internal coding scheme or classification. This may be feasible to support specific use cases but not for the full scope of clinical information.
 - **Outbound communication containing [SNOMED CT expressions](#):**
 - Low: Not supported;
 - Medium: Supported for a few specific types of clinical data in the existing system by mapping to from an existing code system to [SNOMED CT](#) ;
 - High: Supported for most clinical data in the existing system by mapping to from an existing code system to [SNOMED CT](#) .
- **Level 1: Native support for communication of [precoordinated SNOMED CT expressions](#):**
 - **Inbound communications containing [precoordinated SNOMED CT expressions](#):**
 - Low: Supported for some types of information but constrained by data entry and [expression](#) storage capabilities;
 - High: Supported for most types of information.
 - **Outbound communications containing [precoordinated SNOMED CT expressions](#):**
 - Low: Supported but limited by data entry and storage and retrieval capabilities;
 - High: Supported for most types of information.
- **Level 2: Native support for communication of [postcoordinated SNOMED CT expressions](#):**
 - **Inbound communications containing [postcoordinated SNOMED CT expressions](#):**
 - Low: Support limited to particular attributes (e.g. |laterality|, |causative agent|) in [postcoordinated expression](#) ;
 - Medium: Support for general [postcoordination](#) applied to some types of information;
 - High: Able to receive, process and store any valid [postcoordinated expression](#) .
 - **Outbound communications containing [postcoordinated SNOMED CT expressions](#):**
 - Low: Support limited to particular attributes (e.g. |laterality|, |causative agent|) in [postcoordinated expression](#) ;
 - Medium: Support for outbound communication of any [postcoordinated expression](#) that can be entered or stored in the system;
 - High: Support for outbound communication of any valid [postcoordinated expression](#) .