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National System for Geospatial Intelligence (NSG) Enterprise Thesaurus (NET) Standard

(2018-09-25)

Edition 1.0

NATIONAL CENTER FOR GEOSPATIAL INTELLIGENCE STANDARDS

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Introduction

The National System for Geospatial Intelligence (NSG) Enterprise Thesaurus (NET) Standard, Edition 1.0, defines the specification for a controlled, structured semantic resource in which vocabulary terms from two or more vocabularies are organized by semantic relations that make explicit the relationship between the meanings of those terms. This standard consists of a document ("NET Standard") and associated technical artifacts that implement the content of the standard. The NET content consists of pairwise semantic correlations ("term-matches") between vocabulary terms from the NSG Enterprise Vocabulary (NEV) and other terminologies represented using the W3C Simple Knowledge Organization System (SKOS). The purpose of the NET is to support semantic interoperability between SKOS vocabularies that are used in the characterization of Geospatial Intelligence (GEOINT).

The NET Standard presents the information model, two encoding patterns, and the governance process for establishing and managing both this standard and its content. The information model specifies the semantic mapping relations which are used to correlate pairs of terms from different controlled vocabularies. These mapping relations are based on properties defined in the World Wide Web Consortium (W3C) *SKOS Simple Knowledge Organization Reference*. A normative annex to this standard (Annex D) defines additional relations to support mapping terms from NEV component vocabularies.

The NET content is specified separately from the NET Standard in officially published technical artifacts which are implemented in two different W3C encodings for Resource Description Format: RDF/XML and N-Triples.

The NET provides a valuable reference for collaborative efforts across the NSG that require machine-processable semantics to efficiently and effectively exploit GEOINT. The NET content enables improved understanding, search, retrieval, and utilization of resources (including documents, objects, and data instances) that are described using different GEOINT vocabularies. In this way, the NET supports NSG-wide efforts to build a linked open data store of GEOINT resources having consistent, integrated, machine-processable semantics usable by creators and consumers of GEOINT. The NET content supports applications that implement terminology services, tagging and/or indexing, search, display and navigation, and related Web services for GEOINT resources.

Both the NET Standard and NET content are developed and managed under the authority of the National Geospatial-Intelligence Agency (NGA) as a Standards Development Organization (SDO) and executed by the Geospatial Intelligence (GEOINT) Content Standards Board (GCSB). The NET Standard and associated normative technical artifacts are available as registered resources in the online NSG-unique Standards Register of the NSG Standards Registry. The NET content is managed in the online NET Register of the NSG Standards Registry. Metadata records for NET Register items are retrievable through the REST API component of the NSG Standards Registry.

Revision History

Description	Date	Edition
Initial Edition	09/25/2018	1.0

1 Scope

The National System for Geospatial Intelligence (NSG) Enterprise Thesaurus (NET) Standard, Edition 1.0, defines the specification for a controlled, structured semantic resource in which vocabulary terms from two or more vocabularies are organized by semantic relations that make explicit the relationship between the meanings of those terms. This standard consists of a document ("NET Standard") and associated technical artifacts that implement the content of the standard. The NET content consists of pairwise semantic correlations ("term-matches") between vocabulary terms from the NSG Enterprise Vocabulary (NEV) and other terminologies represented using the W3C Simple Knowledge Organization System (SKOS). The purpose of the NET is to support semantic interoperability between SKOS vocabularies that are used in the characterization of Geospatial Intelligence (GEOINT).

The NET Standard presents the information model, two encoding patterns, and the governance process for establishing and managing both this standard and its content. The information model specifies the semantic mapping relations which are used to correlate pairs of terms from different controlled vocabularies. These mapping relations are based on properties defined in the World Wide Web Consortium (W3C) *SKOS Simple Knowledge Organization Reference*.[1] A normative annex to this standard (Annex D) defines additional relations to support mapping terms from NEV component vocabularies.

The NET content is specified separately from the NET Standard in officially published technical artifacts which are implemented in accordance with two W3C Recommendations: *RDF 1.1 XML Syntax* ("RDF/XML") and *RDF 1.1 N-Triples: A line-based syntax for an RDF graph* ("N-Triples").

Both the NET Standard and NET content are developed and managed under the authority of the National Geospatial-Intelligence Agency (NGA) as a Standards Development Organization (SDO) and executed by the Geospatial Intelligence (GEOINT) Content Standards Board (GCSB). The NET Standard and associated normative technical artifacts are available as registered resources in the online NSG-unique Standards Register of the NSG Standards Registry. The NET content is managed in the online NET Register of the NSG Standards Registry. Metadata records for NET Register items are retrievable through the REST API component of the NSG Standards Registry. The NET Standard and the associated NET content evolve in response to NSG community requirements. The governance process, including publication of resources, is described in Section 6.

The NGA is the authority for promulgating the NET Standard and its accompanying technical artifacts for use by the U.S. Department of Defense (DoD), U.S. Intelligence Community (IC), and U.S. civil federal agencies.

2 Conformance

2.1 Conformance Requirements

Any product claiming conformance with the NET Standard and associated NET content shall pass all of the requirements stated in the abstract test suite (ATS) in Annex A, which enumerates the specific elements of conformance.

This standard defines one class of conformance:

- Conformance Class A – Conformance for use of the NET Content

Class A applies to implementations that claim conformance to the NET Standard and associated NET content. These implementations shall use at least one of the two official encodings of the NET content (in RDF/XML or N-Triples). Conformance may be claimed for data or software products, for services, and by specifications, including functional standards. The kinds of applications expected to make use of the NET Standard and normative NET content include:

1. mappings between vocabulary terms from NEV component vocabularies and terms from other vocabularies represented in SKOS;
2. terminology services that provide cross-referenced terms, definitions, and synonyms for multiple terminologies used in shared GEOINT; and
3. applications that use machine-processable terminology for indexing, metadata tagging, and/or search.

[1] *SKOS Simple Knowledge Organization System Reference* (Section 10, Mapping Properties): "These properties are used to state mapping (alignment) links between SKOS concepts in different concept schemes, where the links are inherent in the meaning of the linked concepts."

2.2 Abstract Test Suite

The abstract test suite (ATS) for the NET is specified in Annex A (normative).

3 References

3.1 Normative

The documents listed in Table 1 are indispensable to understanding and using this standard. For dated references, only the cited edition or version applies. For undated references, the latest edition or version of the referenced document (including any amendments) applies. Phrases in square brackets are used as abbreviations for the references within the text of this standard.

Table 1 – Normative References

Standard or Specification
NSG Enterprise Thesaurus (NET) content, encoded in technical artifacts: http://nsgreg.nga.mil/net
IETF RFC 3987, *Internationalized Resource Identifiers (IRIs)*: http://www.ietf.org/rfc/rfc3987.txt
IETF RFC 5646, BCP 47, Tags for Identifying Languages: http://www.ietf.org/rfc/bcp/bcp47.txt [Language Tags]
SKOS Simple Knowledge Organization System Reference (18 August 2009): http://www.w3.org/TR/2009/REC-skos-reference-20090818/ [SKOS Reference]
RDF 1.1 Concepts and Abstract Syntax (25 February 2014): http://www.w3.org/TR/2014/REC-rdf11-concepts-20140225/ [RDF 1.1 Concepts]
RDF 1.1 N-Triples: A line-based syntax for an RDF graph (25 February 2014): http://www.w3.org/TR/2014/REC-n-triples-20140225/ [RDF 1.1 N-Triples]
RDF 1.1 XML Syntax (25 February 2014): http://www.w3.org/TR/2014/REC-rdf-syntax-grammar-20140225/ [RDF/XML Syntax]
W3C XML Schema Definition Language (XSD) 1.1 Part 2: Datatypes (5 April 2012): http://www.w3.org/TR/2012/REC-xmlschema11-2-20120405/
GEOINT Content Standards Board (GCSB) Operations Guide. NGA.SIG.0029_1.0_GCSB: http://nsgreg.nga.mil/doc/view?i=4284

3.2 Informative

The informative (non-normative) documents listed in Table 2 are useful to understanding and using this standard. For dated references, only the cited edition or version applies. Phrases in square brackets are used as abbreviations for the references within the text of this standard.

Table 2 – Informative References

Standard or Specification
ISO 19105:2000. *Geographic information – Conformance and testing* (December 2000): http://www.iso.org/standard/26010.html
ISO 19135-1:2015. *Geographic information – Procedures for item registration – Part 1: Fundamentals*. http://www.iso.org/standard/54721.html
ISO 25964-1:2011. *Information and documentation – Thesauri and interoperability with other vocabularies – Part 1: Thesauri for information retrieval*: http://www.iso.org/standard/53657.html
ISO/IEC 10646:2012, *Information technology – Universal Coded Character Set (UCS)*: http://www.iso.org/standard/56921.html
IETF RFC 1738, *Uniform Resource Locators (URL)*: http://www.ietf.org/rfc/rfc1738.txt

Standard or Specification
IETF RFC 3986, *Uniform Resource Identifiers (URI): Generic Syntax*: http://www.ietf.org/rfc/rfc3986.txt
rdf:PlainLiteral: A Datatype for RDF Plain Literals (Second Edition) (11 December 2012): http://www.w3.org/TR/2012/REC-rdf-plain-literal-20121211/ [RDF Plain Literal]
SKOS Simple Knowledge Organization Primer (18 August 2009): http://www.w3.org/TR/2009/NOTE-skos-primer-20090818/ [SKOS Primer]
ANSI/NISO Z39.19-2005 (R2010). *Guidelines for the Construction, Format, and Management of Monolingual Controlled Vocabularies*: http://groups.niso.org/apps/group_public/download.php/12591/z39-19-2005r2010.pdf
National System for Geospatial Intelligence (NSG) Core Vocabulary (NCV) Standard, Ed. 2.0: http://nsgreg.nga.mil/doc/view?i=4510 [NCV Standard]
Shorter Oxford English Dictionary, *Sixth Edition* (version 3.0.2.1). CD-ROM.

4 Terms, Definitions, and Acronyms

4.1 Terms and Definitions

The terms and definitions[2] used in this standard are presented in the tables below. Sources are indicated if other than this standard.

4.1.1 Thesaurus Terminology

Terms and definitions used in this standard to explain the thesaurus specification are presented in Table 3.

Table 3 – Definitions Applicable to the Specification of the Thesaurus

Term	Definition
broader term	A **vocabulary term** to which another vocabulary term is subordinate in a **hierarchal relationship** because the meaning of the broader term generically includes the meaning of the subordinate term (**narrower term**). NOTE: The scope of the broader term completely includes the scope of the narrower term. The broader term designates a generalization that encompasses the meaning of the narrower term. SOURCE: ISO 25964-1:2011; ANSI/NISO Z39.19-2005 (R2010) (adapted)
concept	A mental representation of knowledge as an abstraction of the essential characteristics of a type of entity, or relationship between entities, in a subject area or domain. NOTE: The concept signified by a **vocabulary term** is specified in the natural-language definition of the term. SOURCE: *The Semantic Web*. Michael C. Daconta, Leo J. Obrst, Kevin T. Smith. 2003.
controlled vocabulary	A set of **vocabulary term**s consisting of defined **lexical item**s (*i.e.*, words, phrases, or abbreviations from a natural language) that are collected and managed by an authority following identified criteria for inclusion. NOTE: Typically, the set of terms and definitions in a controlled vocabulary are selected for consistent and complete coverage of a specified subject area. SOURCE: NCV Standard, Ed. 2.0
hierarchical relationship	A type of directional relationship between two **vocabulary term**s that indicates that the meanings of the terms have a broader (generic) to narrower (specific) relationship, or vice versa. NOTE: In a broader to narrower hierarchical relationship, the scope of the **narrower term** falls completely within the scope of the **broader term**. SOURCE: ISO 25964-1:2011 (adapted); ANSI/NISO Z39.19-2005 (R2010) (adapted)

[2] In definitions, the first occurrence of a term whose meaning is specified elsewhere in Section 4.1 is styled in **bold**.

Term	Definition
lexical item	A word, phrase, or abbreviation represented as a character string that expresses a **concept** in a specified natural language. SOURCE: NCV Standard, Ed. 2.0
mapping property	A **semantic relation** that is used to declare a correlation between a pair of vocabulary terms from different vocabularies, where the nature of the correlation is based on the meaning of the related terms. SOURCE: SKOS Reference (Section 10.1) (adapted)
narrower term	A **vocabulary term** that is subordinate to another vocabulary term in a **hierarchical relationship** because the meaning of the narrower term is included in the meaning of the superordinate term (**broader term**). NOTE: The scope of the narrower term falls completely within the scope of the broader term. The narrower term typically designates a specialization. SOURCE: ISO 25964-1:2011; ANSI/NISO Z39.19-2005 (R2010) (adapted)
reciprocity	A property of relationships such that, for an ordered relation (*R1*) between two terms (for example: from *a* to *b*), there is a second relation (*R2*) that expresses a connection in the reverse direction (*i.e.*, from *b* to *a*), and where the meanings of *R1* and *R2* are related (for example, *R1* means “is narrower than” and *R2* means “is broader than”). NOTE1: Reciprocal relationships may be symmetric (*i.e.*, the same relation indicator is used in both directions, *e.g.*, ‘exact-match’) or asymmetric (*i.e.*, a different relation indicator is used in the reverse direction; *e.g.*, ‘broader’ and ‘narrower’). NOTE2: Semantic relationships between vocabulary terms should have reciprocals; *i.e.*, each **semantic relation** from one term (**source term**) to another (**target term**) should have a corresponding semantic relation in the other direction. SOURCE (NOTE2): ANSI/NISO Z39.19-2005 (R2010)
semantic relation	A formal link between two **vocabulary term**s that represents the relationship between the meanings of the terms (for example, that the meaning of one term is the same as, more general than, or more specialized than the meaning of the other term). SOURCE: SKOS Reference (Section 8)
source term	A **vocabulary term** serving as a starting point when establishing a **semantic relation** between two vocabulary terms. NOTE: Designating a source term is especially important for asymmetric semantic relations (for example, broader, narrower), as well as for documenting coverage of term-matches from one vocabulary to another.
source vocabulary	A **controlled vocabulary** serving as a starting point in translation or in a search for term equivalents. SOURCE: ISO 25964-1:2011 (adapted)
structured vocabulary	A set of **vocabulary term**s that are related by **semantic relation**s. NOTE: A structured vocabulary differs from a glossary, which is a simple vocabulary consisting of a list of words and definitions. SOURCE: NCV Standard, Ed. 2.0
target term	A **vocabulary term** serving as an end point when establishing a **semantic relation** between two vocabulary terms. NOTE: Designating a target term is especially important for asymmetric semantic relations (for example, broader, narrower), as well as for documenting coverage of term-matches from one vocabulary to another.
target vocabulary	A **controlled vocabulary** providing a translation or an equivalent for a **vocabulary term** existing in a **source vocabulary**. SOURCE: ISO 25964-1:2011 (adapted)

Term	Definition
thesaurus	A controlled structured semantic resource in which **vocabulary term**s from two or more vocabularies are organized by pairwise **semantic relation**s which make explicit the relationship between the meanings of the vocabulary terms. SOURCE: ISO 25964-1:2011 (adapted); ANSI/NISO Z39.19-2005 (R2010) (adapted) NOTE: Semantic relations in the NSG Enterprise Thesaurus are between vocabulary terms from different vocabularies.
vocabulary	A set of **vocabulary term**s consisting of defined **lexical item**s (*i.e.*, words, phrases, or abbreviations from a natural language). NOTE: A vocabulary may be structured (*i.e.*, with semantic relations between vocabulary terms) or unstructured (*i.e.*, the vocabulary may consist of a list of defined terms; for example: a simple glossary).
vocabulary term	A defined **lexical item** that represents a **concept** that describes real-world phenomena. NOTE1: A vocabulary term may represent either: (1) a simple concept that characterizes one type or one aspect of real-world phenomena (**basic vocabulary term**); or (2) a complex concept that characterizes a domain of related types or values that may be used to describe real-world phenomena (**complex vocabulary term**). For example, a complex vocabulary term may represent the color-value domain consisting of the set of visible-light color values applicable to appearances of real-world phenomena, while each individual color value is represented by a basic term. NOTE2: Additional optional information may be specified for a vocabulary term, such as additional lexical items that may be used as alternative labels (synonyms) for the concept. SOURCE: NCV Standard, Ed. 2.0

4.1.2 Resource-management Terminology

The terms and definitions used in this standard to describe standards management are presented in Table 4.

Table 4 – Definitions Applicable to NET Resource Management

Term	Definition
change notification (regarding a standard)	A publication in which modifications to selected items in a standard are reported in detail to the community of its users by the applicable maintenance authority. NOTE: In the management of the NET content, a change notification establishes a new **content baseline**. SOURCE: GCSB Operations Guide (Section 2.3.6)
content baseline (of a standard)	The complete set of content of a standard, which is authorized for publication at a specified time. NOTE1: A content baseline is established by publication of a technical artifact containing the content that is valid at that time. NOTE2: A content baseline may be established concurrent with the publication of a new **edition** of a standard, or solely based on changes to the content of a standard. NOTE3: A content baseline is assigned a version number. SOURCE: GCSB Operations Guide (Section 2.3.5)
edition (of a standard)	A publication containing the entire current content of an established standard, and issued by the authorized publication authority, either as the first edition of a new standard or as a new edition (*i.e.*, revised complete version, usually numbered; for example, "2nd edition") of a previously published standard. SOURCE: GCSB Operations Guide (Section 2.3.5)

Term	Definition
Internationalized Resource Identifier (IRI)	A sequence of characters from the Universal Character Set (Unicode/ISO 10646) [IETF RFC 3987], intended for identifying an abstract or physical resource. NOTE1: Every **URI** is by definition an IRI. A mapping from IRIs to URIs is defined, which means that IRIs can be used instead of URIs, where appropriate, to identify resources. SOURCE: IETF RFC 3987 NOTE2: A resource can be anything that has identity, for example, a vocabulary term.
namespace	In RDF, a common **URI** prefix or stem (including a terminal separator) used in identifiers for a set of related resources. NOTE1: The RDF namespace is concatenated with the local name to create the complete URI identifier for an RDF resource. NOTE2: Every RDF resource is identified by a URI. SOURCE (NOTE2): ISO 19150-2:2015 NOTE3: The NET Standard and NET content encodings use the standard prefix names for namespaces as declared in the OWL Structural Specification (Section 2.4).
URI base	A base **URI** in a domain owned by the organization that maintains the model, ontology, or other resource. SOURCE: NCV Standard, Ed. 2.0
Uniform Resource Identifier (URI)	A compact string of characters for identifying an abstract or physical resource. NOTE1: A resource can be anything that has identity (for example, a thesaurus, a controlled vocabulary, or a vocabulary term). NOTE2: A URI identifies a resource either by location, or by name, or both. NOTE3: URIs are limited to a subset of the ASCII character set. SOURCE: IETF RFC 3986
Uniform Resource Locator (URL)	A compact string representation for location and access of a resource available on the Internet. NOTE: A URL is a type of **URI**. SOURCE: IETF RFC1738

4.2 Acronyms

The acronyms that are used in this standard are specified in the following list.

ASCII	American Standard Code for Information Interchange
ATC	Abstract Test Case
ATM	Abstract Test Module
ATS	Abstract Test Suite
API	Application Programming Interface
BCP	Best Current Practice
GCSB	GEOINT Content Standards Board
GEOINT	Geospatial Intelligence
IANA	Internet Assigned Numbers Authority
IEC	International Electrotechnical Commission
IETF	Internet Engineering Task Force
IRI	Internationalized Resource Identifier
ISO	International Organization for Standardization
NCV	NSG Core Vocabulary
NCVX	NCV Auxiliary Ontology
NET	NSG Enterprise Thesaurus
NETX	NET Auxiliary Ontology
NEV	NSG Enterprise Vocabulary
NGA	National Geospatial-Intelligence Agency
NSG	National System for Geospatial Intelligence
OWL	Web Ontology Language
RDF	Resource Description Language

RDFS	RDF Schema
REGX	NSG Register Auxiliary Ontology
REST	REpresentational State Transfer
SDO	Standards Development Organization
SKOS	Simple Knowledge Organization System
UML	Unified Modeling Language
URI	Uniform Resource Identifier
URL	Uniform Resource Locator
W3C	World Wide Web Consortium
XML	Extensible Markup Language

4.3 Presentation Font

The general text of this document is presented using Arial font. Encoding elements for the NET content are presented using Courier New font (*e.g.*, `skos:Concept`).

5 NSG Thesaurus Specification

5.1 Introduction

The NET Standard establishes the terminological, semantic, and structural basis for declaring relationships ("term-matches") between pairs of vocabulary terms from different controlled vocabularies, based on the meanings of the linked terms. A term-match is a binary semantics-based mapping relation together with references to the vocabulary terms that are linked by that relation. The NSG thesaurus specification includes the information model, representation language, and encoding formats required for defining the term-matches which constitute the NET content.

The NET Standard thesaurus specification has three components, which provide:

1. Content specification – the information model for term-matches between vocabulary terms;
2. Content identification – IRIs for identification of the NET content, semantic relations, and referenced vocabulary terms; and
3. Content encoding – Specifications for encodings of NET term-matches in RDF/XML and N-Triples encodings.

Section 5.2 presents background on the historical development and intended uses of thesaurus standards.

Section 5.3 specifies the information model for the NET content in a diagram together with a tabular specification of all included modeling elements.

Section 5.4 specifies the use of the W3C representation language SKOS to represent elements of the information model.

Section 5.5 specifies the implementation of the NET content in two supported encodings: (1) RDF/XML; and (2) N-Triples. The two encodings enable the use of term-matches for SKOS-based vocabularies in either RDF/XML or N-Triples formats to support interoperability of semantics for data exchanged among automated information systems.

5.2 Background: Thesaurus Standards

5.2.1 Modern Thesaurus Standards

Modern thesauri are reference resources designed to relate words and phrases by their meanings in order to improve language understanding and usage. In English, *Roget's Thesaurus* (originally published in 1852) is the best-known linguistic or literary reference of that type. In recent decades, information professionals at libraries, businesses, and government agencies have created enterprise thesauri for use in indexing and searching the library resources and other document collections under their management (ISO 25964-1:2011 (Introduction)). Standards organizations have developed thesaurus standards that defined terminology, methods, and best practices to be followed in the construction of thesauri for single languages, multiple languages, and specialized domains.

With the advent of computerized systems for managing digitized records and other digitized resources, new thesaurus standards (or new versions of previous standards) have addressed technical issues related to managing resources in automated information systems. The development and use of thesauri is often considered as part of the larger topic of controlled vocabularies. The ANSI/NISO standard *Guidelines for the Construction, Format, and Management of Monolingual Controlled Vocabularies* (Z39.19-2005 (R2010)) "focuses on controlled vocabularies that

are used for the representation of content objects in knowledge organization systems including lists, synonym rings, taxonomies, and thesauri". According to that standard, "[t]he primary purpose of vocabulary control is to achieve consistency in the description of content objects and to facilitate retrieval". The ANSI/NISO definition of 'thesaurus' is: "A controlled vocabulary arranged in a known order and structured so that the various relationships among terms are displayed clearly and identified by standardized relationship indicators." (ANSIO/NISO Z39.19-2005 (R2010), Clause 4.1)

The ISO standard *Information and documentation – Thesauri and interoperability with other vocabularies – Part 1: Thesauri for information retrieval*, ISO 25964-1 (2011-08-15), acknowledges from the outset that contemporary "thesauri are mostly electronic tools" that are "built and maintained with the support of software and need to integrate with other software, such as search engines and content management systems." The ISO definition of 'thesaurus' is: A "controlled and structured vocabulary in which concepts are represented by terms, organized so that relationships between concepts are made explicit, and preferred terms are accompanied by lead-in entries for synonyms or quasi-synonyms." (ISO 25964-1:2011, Clause 2.62)

The publication of the W3C standard *SKOS Simple Knowledge Organization System Reference* (18 August 2009) enabled the creation of terminologies as knowledge organization systems that could be encoded and shared across the Internet for use by systems capable of processing and interpreting these new kinds of semantic resources in W3C formats.

While the objective of controlled vocabularies is to establish consistent terminology for use in shared resources and shared areas of endeavor, it must also be recognized that organizational and linguistic factors prevent complete standardization of vocabularies across all domains. The use of a thesaurus enables the mapping (*i.e.*, alignment or correlation) of terms from different vocabularies so that users (both humans and automated information systems) familiar with one terminology may find and utilize resources that have been described or indexed by communities using another nomenclature.

5.2.2 The NSG Enterprise Thesaurus Standard

The NET Standard is based on W3C Recommendations that support the Semantic Web (Section 5.4). The standard defines an approach, infrastructure, and content for establishing semantic relationships between vocabulary terms from different Web-enabled vocabularies. Term-matches are declared using semantic relations based on the mapping relations defined in the W3C SKOS Reference (Section 10). Internationalized Resource Identifiers (IRIs) are used to identify the semantic relations, as well as to identify the vocabulary terms linked in the NET content.

The normative NET content does not define any vocabulary terms. Vocabulary terms related by NET term-matches are referenced by identifiers (IRIs) assigned in the vocabularies where the terms are defined. For Web-enabled vocabularies, the term IRIs provide links to the full specification of the terms in their vocabularies.[3] The content of the NET is the collection of semantic relationships declared between pairs of vocabulary terms which are defined externally in their respective vocabularies. In this respect, the NET differs from thesauri that include both the specifications of vocabulary terms and the semantic relationships between them. The NET content references GEOINT terminology that is defined in components of the NSG Enterprise Vocabulary (NEV). The NET content contains term-matches between vocabulary terms in NEV components and terms in non-NSG vocabularies.

The NET Standard specifies that the NET content be published in two W3C encodings: RDF/XML and N-Triples, which enables the NET content to be exchanged and utilized by automated information systems in a machine-processable way. The NET content is published online in registered technical artifacts available in the Document Registry of the NSG Standards Registry. The collection of term-matches is also available through the REST API component of the NSG Standards Registry. Publication of the thesaurus content is explained in Section 6.2.

All vocabularies whose terms are referenced in the NET content shall be represented in SKOS using one of the concrete RDF syntaxes defined by the W3C [RDF/XML Syntax (Introduction)]. In addition, each vocabulary term shall minimally specify a name (*i.e.*, preferred lexical item used to designate the meaning of the term in a specified natural language) and a definition (*i.e.*, a statement that conveys the meaning of the term to a human user in a specified natural language).

5.3 NET Information Model

5.3.1 Introduction

This section defines the information model for representing the content of the NET and specifies two encodings for that content. The NET information model specifies the modeling concepts needed to represent a term-match, including the mapping relations and the minimum attribution required for the vocabulary terms.

[3] Web-enabled vocabulary resources may be published on the Internet or on a restricted network.

The NET information model consists of the following information-modeling concepts:

- A class for representing vocabulary terms,
- A class for representing a term-match,
- An enumeration specifying the semantic mapping relations,
- A set of constraints specifying the reciprocal term-match for each semantic relation,

together with attributes and associations between classes.

Section 5.3.2 specifies the modeling concepts of the NET information model in the form of a diagram (Figure 1), followed by a tabular presentation of definitions for those concepts.

Section 5.3.3 specifies the datatypes used by the model.

NOTE: Metadata about individual term-matches in the NET content is managed in the online NET Register within the Vocabulary Registry of the NSG Standards Registry. The logical data model for the NET Register is presented in Annex C.

5.3.2 NET Information Model Concepts and Definitions

The NET information model is presented diagrammatically in Figure 1.[4] A description of the model concepts in tabular format follows the diagram.

Each concept of the NET information model is defined in the tables below, using the following table format to document the individual elements:

- The **Reference** column consists of a sequentially assigned, non-normative identifier of the element (class or property) that is provided for cross-referencing purposes. It may vary from version-to-version of this document.
- The **NET Modeling Concept** column specifies the class name, class attribute name, or class role name of the information modeling concept. For clarity, role names are prefixed by the italicized phrase "*Role name*".
    - A specified class in the model has a capitalized name and always appears in the table on a grey-highlighted row above its properties.
    - The properties (attributes and/or association roles) of a model class are specified in subsequent rows of the table below the class row.
- The **Definition** column specifies the definition of the model class or property.
- The **Source of Definition** column records the source of the definition of the information modeling concept, if other than the NET Standard; otherwise, "NET Standard".
- The **Obligation** column specifies if the property is **Mandatory**, Conditional, or *Optional*.
    - Properties whose obligation is *"***Mandatory**" shall be populated in accordance with the property definition and any associated guidance.
    - Properties whose obligation is "Conditional" are mandatory when the stated condition is satisfied, in which case they shall be populated in accordance with the property definition and any associated guidance.
    - Properties whose obligation is *"Optional*" are optional, but their population is good business practice when the applicable information is available.
- The **Multiplicity** column indicates the number of instances of the value type of the property that are permitted by this information model. In the case that more than a single domain value of the property is allowed, an indication may also be included in this column if the ordering of the domain values is significant.
- The **Value Type** column indicates the modeling concept or datatype that is used to define the value(s) of the property.

[4] See Annex F for an explanation of the notation.

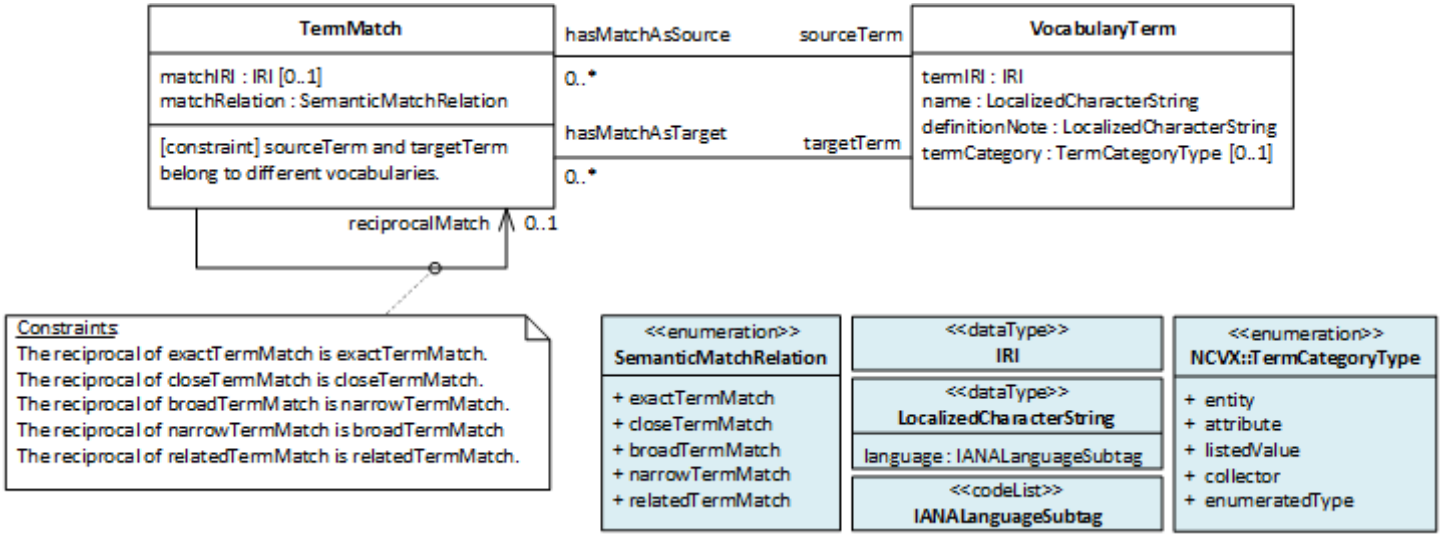

Figure 1 – Overview of the NET Information Model

A description of the model concepts follows in tabular format.

Table 5 – The Class TermMatch and its Properties

Reference	NET Modeling Concept	Definition	Source of Definition	Obligation	Multiplicity	Value Type
1.	TermMatch	A relationship between a vocabulary term in a source vocabulary to a vocabulary term in a target vocabulary, based on the meanings of the two terms, and including references to the source term, target term, and specific semantic relation.	NET Standard			
2.	matchIRI	An Internationalized Resource Identifier (IRI) that uniquely identifies a term-match as a resource.	NET Standard	*Optional*	Zero or one	IRI
3.	matchRelation	The semantic relation assigned by this term-match to indicate the relationship of the meaning of the source term to the meaning of the target term.	NET Standard	**Mandatory**	Exactly one	SemanticMatchRelation
4.	*Role name:* sourceTerm	The vocabulary term in the source vocabulary for which a term-match is assigned in a target vocabulary.	NET Standard	**Mandatory**	Exactly one	VocabularyTerm
5.	*Role name:* targetTerm	The vocabulary term to which a term-match is assigned if a match exists in the target vocabulary.	NET Standard	**Mandatory**	Exactly one	VocabularyTerm
6.	*Role name:* reciprocalMatch	A term-match specifying the semantic relation in the reverse direction (from the target term to the source term) of the semantic relation in this term-match.	NET Standard	*Optional*	Zero or one	TermMatch

Table 6 – The Class VocabularyTerm and its Properties

Reference	NET Modeling Concept	Definition	Source of Definition	Obligation	Multiplicity	Value Type
1.	VocabularyTerm	A defined lexical item (*i.e.,* a word, phrase, or abbreviation in a specified natural language) which represents a concept that describes real-world phenomena.	NET Standard			
2.	termIRI	A uniform resource identifier (URI) that uniquely identifies a vocabulary term, consisting of the vocabulary IRI concatenated (following a separator) with the label of the vocabulary term.	NET Standard	**Mandatory**	Exactly one	IRI
3.	name	The preferred human-readable lexical item (i.e., word, phrase, or abbreviation) that is used to represent a concept in a specified language. EXAMPLE: “Railway Yard”	NET Standard	**Mandatory**	Exactly one	LocalizedCharacterString
4.	definitionNote	A precise statement of the nature and normative properties of a concept (definition), followed by an optional statement (description) about relevant non-essential qualities, variations, scope, and/or examples of the concept. NOTE: For a concept representing an attribute, the value type and (if applicable) physical quantity for possible attribute values may be indicated. EXAMPLE: The definitionNote of the term labeled "Horizontal Clearance" is: "Definition: The distance available to pass a load that extends laterally beyond the wheels of a vehicle. Description: [None Specified] Value Type: Real Interval: Non-negative. Physical Quantity: Length."	NET Standard	**Mandatory**	Exactly one	LocalizedCharacterString
5.	termCategory	The type of a vocabulary term, indicating whether the term represents a concept that describes an entity, an attribute, a listed value (in a value domain), a value domain (of listed values), or a subject domain (of entity and/or attribute types).	NCV, Ed. 2.0 (Annex D.2)	Conditional (for NEV Vocabulary Terms)	If applicable, then exactly one.	TermCategoryType
6.	*Role name:* hasMatchAsSource	A term-match in which this vocabulary term is the source term.	NET Standard	Conditional (if there is a match in the target vocabulary)	If applicable, zero or more.	TermMatch
7.	*Role name:* hasMatchAsTarget	A term-match in which this vocabulary term is the target term.	NET Standard	Conditional (if there is a match in the source vocabulary)	If applicable, zero or more.	TermMatch

5.3.3 Datatypes in the NET Information Model

5.3.3.1 Introduction

The NET information model includes the following datatypes which are specified as value types for properties in the information model.

5.3.3.2 IRI

The datatype IRI represents International Resource Identifiers (IRIs). An IRI is a finite-length sequence of characters from the Universal Character Set (Unicode/ISO 10646) that is intended to identify an abstract or physical resource as described in IETF RFC 3987. The value may be absolute or relative, and it may have an optional fragment identifier (that is, it may be an IRI Reference).

5.3.3.3 LocalizedCharacterString

The datatype LocalizedCharacterString, defined in Table 7, represents a character string for which the natural language to use in interpreting the content is specified by a formal identifier (*i.e.*, a language code or token). The language code is a lowercase abbreviation for the natural language of the expression represented by a character string. A character string is a finite-length sequence of zero or more characters from the Universal Character Set (Unicode).

Table 7 – The <<dataType>> LocalizedCharacterString and its Properties

Reference	NET Modeling Concept	Definition	Obligation	Multiplicity	Value Type
1.	LocalizedCharacterString	A character string for which the natural language to use in interpreting the content is specified by a formal identifier (a language code or token).			Subclass of <<dataType>> CharacterString
2.	language	The natural language to be used for interpreting the content of a character string, as indicated by a formal identifier (a code) conformant with BCP 47. NOTE: Two-character lowercase language abbreviations based on IETF RFC 5646 codes (for example: 'en' for English) are specified for maximum interoperability.	**Mandatory**	Exactly one	<<codeList>> IANALanguageSubtag

5.3.3.4 IANALanguageSubtag

The codelist IANALanguageSubtag represents a set of formal identifiers for natural languages, as defined by BCP 47 (currently represented by RFC 4646 and RFC 4647) or its successor(s). IANALanguageSubtag values are the lowercase two-character codes contained in the Language Subtag registry administered by the Internet Assigned Numbers Authority (IANA) in accordance with the Internet Engineering Task Force (IETF) Recommendation for Comment (RFC) 5646.[5] The language codes in the IANA Language Subtag registry are based on the International Organization for Standardization (ISO) 639 series of standards.

5.3.3.5 SemanticMatchRelation

The enumeration SemanticMatchRelation represents a set of concepts that describe the nature of the correlation in meaning between two terms from different vocabularies. The enumerants are based on the SKOS mapping properties defined in the W3C SKOS Reference (Section 10). The examples are based on a sample mapping in which the source vocabulary is the DoD Installation Geospatial Vocabulary (IGV) and the target vocabulary is the NSG Core Vocabulary (NCV).

[5] The complete IANA Language Subtag registry content is available at the following URL: http://www.iana.org/assignments/language-subtag-registry/language-subtag-registry.

Table 8 – The <<enumeration>> SemanticMatchRelation and its Enumerants

Reference	NET Modeling Concept	Definition
1.	SemanticMatchRelation	The set of coded domain values that specify the types of correlation between the meaning of a vocabulary term in a source vocabulary and the meaning of a target term in a target vocabulary, evaluated in the direction from the source term to the target term. NOTE: Some semantic relations are symmetric (for example, an exact match, which indicates that the meanings of source term and target term are the same in both directions), while others are asymmetric (for example, a broader match, in which the source term has a more specialized meaning than the target term and thus cannot be used interchangeably).
2.	exactTermMatch	The source vocabulary term and target vocabulary term are equivalent in meaning. NOTE1: Linguistically, two vocabulary terms correlated by this relation have the same sense (concept) and apply to the same denotations (entities). Pragmatically, the two terms can be used interchangeably across all applications that are able to process the two vocabularies to which the terms belong. NOTE2: The exact-match property is symmetric: If term A is an exact match with term B, then term B is an exact match with term A. The exact-match relation is transitive: If a term A is an exact match with term B, and term B is an exact match with term C, then term A is an exact match with term C. EXAMPLE: ‘Bathymetry Area’ (IGV) to ‘Depth Area’ (NCV).
3.	closeTermMatch	The source vocabulary term and target vocabulary term are sufficiently similar in meaning that they can be used interchangeably in specified contexts. NOTE1: Linguistically, the two terms related by this property are similar enough in meaning to denote the same entities in some contexts. Pragmatically, the two terms are sufficiently similar that they can be used interchangeably in some information-retrieval applications that are able to process the two vocabularies to which the terms belong. NOTE2: The close-match property is symmetric: If term A is a close match with term B, then term B is a close match with term A. However, the close-match relation is not transitive, because the correlated vocabulary terms might not be equivalent in every context; therefore, the relation cannot be propagated across different pairs of close matches in which a term A is referenced. EXAMPLE: ‘Campground’ (IGV) to ‘Camp-site’ (NCV).
4.	broadTermMatch	The source vocabulary term has a more specialized meaning than the target vocabulary term. NOTE1: Linguistically, all denotations of the source term are also denotations of the target term; however, the target term denotes additional items that are not denoted by the source term. Pragmatically, the broader (target) term can be used to collect all items tagged or denoted by the source term. NOTE2: The broad-match relation is the inverse of the narrow-match relation. EXAMPLE: ‘Cemetery Plot’ (IGV) to ‘Grave’ (NCV).
5.	narrowTermMatch	The source vocabulary term has a more general meaning than the target vocabulary term. NOTE1: Linguistically, the denotations of the source term include all denotations of the target term, plus additional items that are not denoted by the target term. Pragmatically, the narrower (target) term is a specialization of the source term. NOTE2: The narrow-match relation is the inverse of the broad-match relation. EXAMPLE: ‘Site Access Control’ (IGV) to ‘Checkpoint’ (NCV).
6.	relatedTermMatch	The source vocabulary term and target vocabulary term have meanings that are relevant to each other in some way that is neither equivalent, similar, nor more general or specific. NOTE1: The related-match relation may be considered symmetric at the most general level of application: If term A is a related term to term B, then term B is a related term to term A. However, specializations of related-match might not be symmetric (see NOTE2). NOTE2: Special types of related-terms include: cause and effect; raw material and product; practice and practitioner. EXAMPLE: ‘Shoreline’ (IGV) to ‘Shoreline Construction’ (NCV).

5.3.3.6 TermCategoryType (NCV Standard, Ed. 2.0)

TermCategoryType is defined in the NCV Standard, Ed. 2.0 (Section 5.3.6.8). Vocabulary terms in all NEV component vocabularies are required to have a term category declared. Term categories are not required for vocabulary terms in non-NEV vocabularies. Where available, term categories provide additional insight into the meaning of a vocabulary term.

The enumeration TermCategoryType represents the set of coded domain values that specify whether a vocabulary term denotes an object (entity), a property (attribute), an allowed value (listedValue), a value domain (enumeratedType), or a subject domain (collector). Term categories are mutually exclusive. The domain values defining these categories are defined in Table 9, below.

Table 9 – Domain Values for the <<enumeration>> TermCategoryType (NCV Standard, Ed. 2.0)

Reference	NET Modeling Element	Definition
1.	TermCategoryType	The set of coded domain values that specify the kind of concept represented by a particular vocabulary term. NOTE: Term categories are mutually exclusive. A vocabulary term may denote an object (entity), a property (attribute), a possible value (listedValue), a value domain (enumeratedType), or a subject domain (collector). SOURCE: NCV Standard, Ed. 2.0 (Section 5.3.6.8)
2.	entity	The term represents a concept that describes a type of real-world phenomenon. NOTE: An entity type is an abstraction that characterizes real-world phenomena. EXAMPLES: (NCV) “Bridge”, “Person”, “Mountain”, “Event”.
3.	attribute	The term represents a concept that describes a characteristic of an entity. NOTE: A characteristic will have a specific value in relation to a particular entity. EXAMPLES: (NCV) (1) "Length" (for a physical object, with a value in physical distance); (2) “Color” (for a physical object, with a specified value either in a qualitative color range, or in a wavelength of light); (3) “Principal Activity” (for an organization, with an activity type as value).
4.	listedValue	The term represents a concept that describes a value from an enumerated type. EXAMPLES: (NCV) “Intact”, “Damaged”, “Destroyed”, “Dismantled”, “Unmaintained”, or “Construction” (to characterize the condition of a physical object).
5.	collector	The term represents a concept of a subject domain that describes a set of specialized vocabulary terms. NOTE: A CollectorTerm groups basic vocabulary terms that are used to describe a specific subject domain. EXAMPLES: (NEV) “Quality Measures”, “Coordinate Reference Systems”, and “Belief Systems”.
6.	enumeratedType	The term represents a concept that describes a value domain consisting of a set of possible values, either closed (enumeration) or open (codelist), for a property of an entity. NOTE: An EnumeratedTypeTerm groups basic vocabulary terms (called ListedValueTerms) that represent the individual values. EXAMPLE: An enumerated type for biological sex comprising the values “Male” and “Female”.

5.4 Representation of NET Content using Semantic Web Languages

5.4.1 The Semantic Web

The information modeling elements of the NET information model can be represented using the Simple Knowledge Organization System (SKOS), as defined by W3C Recommendations for the Semantic Web. The use of SKOS enables the encoding of NET content in machine-readable formats that can be used with Web-based applications and shared on the Web to provide machine-processable semantics for GEOINT data characterized using different vocabularies (for example, in linked data).[6]

[6] A similar approach to data definition and data linking may be used in a closed networked system, rather than on the open Internet, when required for mission-specific purposes.

The Semantic Web is a virtual set of distributed data accessible on the Internet that is represented using standards-based, machine-processable descriptions that allow the data to be application-independent and available for re-use in accordance with a framework of common standards.[7] Data in the Semantic Web can be discovered, queried, aggregated, and analyzed as part of the larger information ecosystem by leveraging the semantics (*i.e.*, meanings) of the data. The phrase "the Web of Data" is used synonymously with the Semantic Web in this sense.[8]

The term "Semantic Web" also encompasses the technologies, including the standards and operational infrastructure, that support the creation of the Web of Data. Semantic Web standards define a framework (including representation languages and exchange formats) for describing data in a reusable, machine-processable way, as well as guidelines for creating the operational environment on the Web.[9] Finally, the Semantic Web relies on an implemented technology infrastructure that enables the real-time publication, linking, and processing of data published in Semantic Web exchange formats.

The set of standards used to enable sharing of the semantics of information on the Web is often referred to as the "Semantic Web Stack", because later recommendations built upon and extended the capabilities of earlier standards. Figure 2 shows graphically the reliance on and dependencies among the recommendations and standards that are used together to enable the Semantic Web. Contributions of different layers of the stack are explained below.

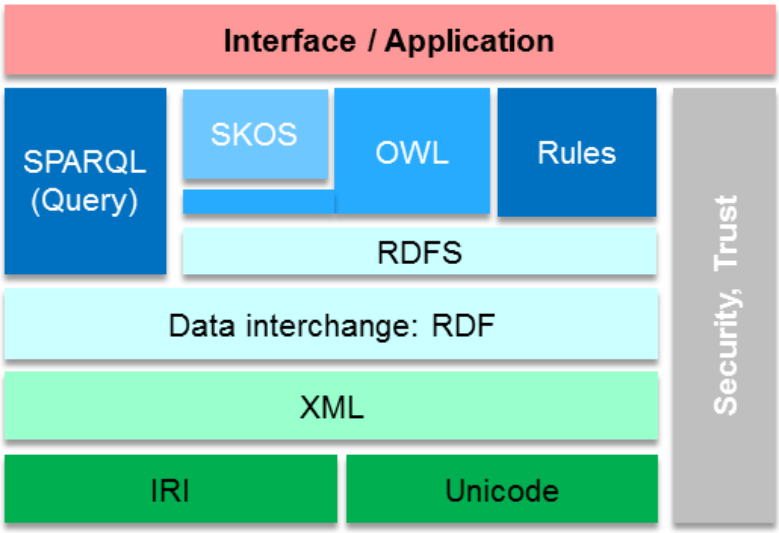

Figure 2 – The Semantic Web Stack[10]

The World Wide Web Consortium (W3C) has developed a core set of recommendations (standards) that can be used together with non-W3C standards (such as Unicode) to support the representation and exchange of information on the Web. All of these recommendations depend upon unique identifiers using standardized character sets to identify resources on the Web. Initial efforts to support the sharing of information on the Web through the creation of Extensible Markup Language (XML)[11] focused on the representation of individual data objects (*i.e.*, instance data) together with metadata about them. Subsequent recommendations (RDF, RDFS, and OWL) defined new representation languages that are used to formalize the semantics of data and its real-world domains in a machine-processable form. RDF, RDFS, OWL, and rule languages enable support for automated logical reasoning about data (*e.g.*, inferencing to conclude additional facts from known data) as well as querying distributed data resources across the Web.

SKOS is a W3C standard that defines another kind of representation language. While SKOS incorporates some aspects of earlier approaches in thesaurus and terminology management, the SKOS representation language provides a new framework for expressing controlled vocabularies and the concepts they represent in a format

[7] *The Semantic Web*. Michael C. Daconta, Leo J. Obrst, and Kevin T. Smith. Wiley Publishing, Inc. 2003. Page 4.
[8] Linked Data Glossary, W3C Working Group Note 27 June 2013 (http://www.w3.org/TR/ld-glossary/)
[9] "The Semantic Web provides a common framework that allows data to be shared and reused across application, enterprise, and community boundaries." (W3C FAQ, *What is the Semantic Web*: http://www.w3.org/2001/sw/SW-FAQ)
[10] Based on *Semantic Web and Other W3C Technologies to Watch*. Steve Bratt, CEO, W3C. October 2006. Retrieved online at: http://www.w3.org/2006/Talks/1023-sb-W3CTechSemWeb/. There is some variation in depictions of the stack, which has changed over the years with the addition of new recommendations such as the Rules Interchange Format (RIF) and the adoption of IRIs to provide a broader method than URIs for constructing unique identifiers. There are also variations in which the diagram consists of uniform flat layers, although in fact the relationship between layers is more complex than in the stack-of-pancake depictions.
[11] XML was developed in the late 1990s to provide a syntax for creating markup languages to capture metadata.

sharable on the Web.[12] SKOS is a common data model for knowledge organization systems, including vocabularies, thesauri, and categorization schemes. A knowledge organization system is a collection of meaningful natural language terms (sometimes called "concepts") selected and optionally organized into a structure (such as a hierarchy or association network) to provide an intuitive map of one or more subject domains. These systems may be used for the description, indexing, or retrieval of documents and other resources. They do not, however, define classes and properties, and they are not used to state formal axioms or facts about the world (as OWL does).[13] The SKOS representation language itself is formally defined in OWL.

5.4.2 NET Representation using SKOS and RDF Triples

The elements of the NET information model are represented using SKOS[14] and RDF triples. NET semantic match relations are based on the mapping properties defined in Section 10 of the W3C SKOS Reference. Term-matches are represented using RDF triples consisting of the two IRIs for vocabulary terms linked by the appropriate semantic match relation.

The vocabulary terms referenced in a term-match are defined in their home vocabularies using either the class SKOS Concept or the class SKOS Concept Scheme. Vocabulary terms referenced by NET term-matches shall be identified by IRIs (Section 5.4.3) and have at minimum a preferred name and definition. Vocabulary terms from NEV component vocabularies also have an assigned term category.

For vocabulary terms that are instances of the SKOS class Concept, the SKOS standard defines mapping properties that can be used directly as semantic match relations to correlate instances of SKOS Concept.

The SKOS class Concept Scheme represents groupings of SKOS Concepts. NEV component vocabularies, which are based on the NSG vocabulary information model defined in the NCV Standard, Ed. 2.0, utilize both SKOS Concept and SKOS Concept Scheme to define vocabulary terms.[15] For example, a vocabulary term 'Primary Color' may be represented by a Concept Scheme to which vocabulary terms for the individual primary colors (such as 'Blue', 'Yellow', and 'Red') are related. The SKOS representation language does not provide semantic relations for correlating Concept Schemes (for example, to represent that 'Primary Color' is a narrower term than a Concept Scheme 'Color', which is related to more colors). For that purpose, this standard defines additional properties which are used to represent semantic match relations for term-matches involving at least one vocabulary term represented by a Concept Scheme. The properties are defined in a small ontology (namespace abbreviation: 'netx') that is available online (see Annex D).

The specific encodings of NET information model elements using SKOS are presented in Section 5.5.

5.4.3 Unique Identifiers for Vocabulary Terms: IRIs

Vocabulary terms related by NET term-matches are referenced using Internationalized Resource Identifiers (IRIs). An IRI is a finite-length sequence of zero or more characters used for identifying an abstract or physical resource. A resource can be anything that has identity. IRIs may be used solely for identification of resources, or they may also be used to locate and access resources.

> **NOTE** An Internationalized Resource Identifier is a sequence of characters from the Universal Character Set (Unicode/ISO 10646) that forms an identifier for a resource. IRIs complement an older format, Uniform Resource Identifiers (URIs), which allows the use of only a subset of the ASCII character set to construct identifiers. A standardized mapping from IRIs to URIs is defined in the IRI specification. When a resource identifier is used for resource retrieval, it may be necessary to determine the associated URI, because retrieval mechanisms may be defined only for URIs. Every URI is by definition an IRI.[16]

An encoding of the complete NET content is a Web resource identified by an IRI that is a URI. The retrieved Web resource contains the full set of term-matches. Each term-match in the NET content is represented by a triple consisting of the IRIs for two vocabulary terms joined by a semantic match relation that is also identified by an IRI.

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[12] SKOS Reference (Section 1.1).
[13] OWL, the W3C ontology representation language, differs from SKOS in both of those respects; ontologies define classes and properties that are used to state axioms and facts about the world. The structures used in knowledge organization systems do not have formal semantics. (SKOS Reference (Section 1.3)) While they may be queried, they do not support formal inference.
[14] *SKOS Simple Knowledge Organization System Reference* (18 August 2009); accessed online at: http://www.w3.org/TR/2009/REC-skos-reference-20090818/
[15] NCV Standard, Ed. 2.0 (Section 5.3.3 and Section 5.5.4).
[16] See: http://tools.ietf.org/html/rfc3987#section-3.1.

5.4.4 Resource Documentation for the NET

The NET content shall be available as a Semantic Web resource consisting of a collection of RDF triples that encode NET term-matches. The resource shall be documented with the following information in a comment header included in the resource files retrievable from the Document Registry and through the REST API component of the NSG Standards Registry. Example headers are presented in Section 5.5.3.

a) Name – The name for the resource, optionally with abbreviation (*i.e.*, "NSG Enterprise Thesaurus (NET))".

b) Namespace – The URI base plus separator ("/") that is used to identify the NET content as a Web resource (*i.e.*, the collection of term-matches).

c) Resource – The name and URL for the edition of the NET Standard document that contains the specification for the NET content.

d) Supporting Resources – The name and URI for the NETX ontology (see Annex D), and the URL for the Resource page for NET encodings.

e) Definition – The summary of essential information that should be used when cataloguing the NET content resource in a register or repository.

f) Description – Additional information about the NET content.

g) Version Number – (Registered technical-artifact encodings only) A structured character sequence including numbers, which uniquely specifies an NET content baseline designated as an official version.

h) Date of Last Change – (REST API encodings only) A structured character sequence indicating the most recent date on which the NET content included in the resource was changed (added, updated, or deleted).

5.5 NET Content Encodings

5.5.1 Introduction

An encoding of NET content provides a machine-interpretable SKOS representation of all term-matches in the NET content. NET content encodings may be used with Semantic Web tools to enhance management, search, and/or retrieval of GEOINT resources that have been characterized using vocabulary terms from one of the correlated vocabularies.

The NET Standard specifies two technology-specific encodings of the NET content. Each encoding accurately represents the NET information model (Section 5.3):

a) RDF/XML encoding – RDF/XML is an XML-based format for encoding an RDF graph. [RDF/XML Syntax]

b) N-Triples – N-Triples is a line-based, plain-text format for encoding an RDF graph that may be used in information exchange without necessitating the complicated parsing required for RDF/XML. In N-Triples, each line consists of a sequence of three RDF terms representing, respectively, the Subject, Predicate, and Object of an RDF triple. [RDF 1.1 N-Triples]

The following sections present the general aspects of the NET content encodings, followed by specific differences for the RDF/XML and N-Triples encodings. Both encodings use IRIs as described in Section 5.5.2. Section 5.5.3 describes the approach to documenting the NET content resource. Section 5.5.4 presents the approach for encoding the information modeling concepts of the NET information model. Section 5.5.5 presents the general encoding for datatypes. Section 5.5.6 provides technology-specific guidelines for the RDF/XML and N-Triples encodings of the NET content.

The publication of the NET content encodings and REST API access to them is described in Section 6.2.

5.5.2 Namespace and Identifiers

5.5.2.1 Introduction

In the World Wide Web, resources must be uniquely identified by IRIs. The NET content resource containing the collection of term-matches encoded as RDF triples is assigned an IRI that is used to retrieve that resource. The individual vocabulary terms related by term-matches are identified by their IRIs in the source and target vocabulary namespaces. Individual elements of SKOS and other representation languages used to represent NET content are also identified by IRIs.

5.5.2.2 Namespace

A namespace represents a collection of resources which are referenced using identifiers (IRIs) that share a common initial prefix or “stem” (also referred to as a URI base). An RDF namespace specifies a URI base used in all identifiers for a set of related resources. The namespace URI base is concatenated with a separator followed by a local name to create the complete IRI identifier for an individual RDF resource.[17]

Each IRI belongs to a single namespace. Resources from different namespaces may be combined in the construction of a new resource. The NET content encodings re-use semantic relations from SKOS and vocabulary terms defined in SKOS-based vocabularies. Every modeling element used by an NET content encoding has a unique IRI that identifies that element in relation to its original namespace. For example, the SKOS property exactMatch (IRI: http://www.w3.org/2004/02/skos/core#exactMatch) is in the SKOS namespace (IRI: http://www.w3.org/2004/02/skos/core#).

Namespaces may be abbreviated using prefixes handled by XML parsers. NET content encodings in RDF/XML use prefix names for common namespaces as defined in the OWL Structural Specification (Section 2.4).

5.5.2.3 Identifier (IRI) for NET Content

The NET Standard specifies a unique, non-versioned identifier for the NET content as a resource containing the set of all valid term-matches for a particular content baseline or dated resource.

The IRI designation for NET content resources is constructed in accordance with the following pattern:

protocol "://" *domain* "/" *resource-type* "/" *resource*

Each component in the pattern is case-sensitive and determined as follows:

- *protocol* – always 'http'
- *domain* – always 'api.nsgreg.nga.mil'
- *resource-type* – always ‘vocabulary’
- *resource* – always 'net'

The individual IRI components are concatenated into a single string as specified by the pattern (above), to form the IRI that designates the NET content resource:

- NET content IRI: http://api.nsgreg.nga.mil/vocabulary/net

The NET content IRI is in the form of a URI that is a Uniform Resource Locator (URL). A URL specifies the location of, and access to, a resource on the Internet. A URL specifies the protocol of the resource (*e.g.*, 'http' or 'ftp'), the domain name for the resource (*e.g.*, 'nsgreg.nga.mil'), and the relative location of the resource within that domain. If the site host is active, then accessing the specified resource results in retrieval of a representation (*i.e.*, the content) of the resource; however, site persistence is not guaranteed.

For convenience, the REST API component of the NSG Standards Registry supports the retrieval of all currently valid term-matches in the NET when a request is made using the non-versioned IRI.

Individual NET term-matches do not have IRIs because they are encoded by RDF triples, which do not support identification by an IRI.[18] Information about individual term-matches in the NET content is available in the NET Register and in an XML encoding based on the NET Register content (Annex C).[19] Each vocabulary term referenced in an NET term-match has a unique identifier (IRI) based on the namespace of the vocabulary in which that term is defined.

5.5.3 Resource Documentation

Each encoding of the NET content shall be described by the information specified in Section 5.4.4. This information shall appear in the header of the encoding and should also be used when cataloguing the NET content in a registry or repository. Documentation for NET content as a registered technical artifact will contain a version number, while documentation for NET content as a resource retrieved through the REST API will contain a date of last change. Each NET content resource shall indicate either the version number or the date of last change for that content.

[17] In the concatenation of a URI base with a local name, a separator (which may be either the hash (“#”) or the forward slash (“/”)) character is required between the two parts. The type of separator used depends upon the supported retrieval mechanism.
[18] The W3C Recommendation for RDF N-Quads (http://www.w3.org/TR/n-quads/) defines a representation to add identifiers to RDF triples. Some applications support the addition of identifiers to RDF triples.
[19] See Annex C.3 for the IRI pattern for the XSD.

Figure 3, below, illustrates the inclusion of the required metadata in the header of an NET content encoding that is a registered technical artifact. Each registered technical artifact has a version number, which is included in the documentation.

Figure 4 illustrates the inclusion of the required metadata in the header of an NET content encoding that is retrieved through the REST API component of the NSG Standards Registry. Each REST API resource that collects the NET content has a date of last change included in the documentation, rather than a version number.

```
<!--++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
+
+   NSG Enterprise Thesaurus (NET)
+
+   Namespace: http://api.nsgreg.nga.mil/vocabulary/net/
+   Resource:  http://nsgreg.nga.mil/doc/view?i=4627
+              NSG Enterprise Thesaurus (NET) Standard, Edition 1.0
+              NGA.STND.0070_1.0_NET
+   Supporting
+     Resources: NETX (ontology): http://api.nsgreg.nga.mil/ontology/netx/1.0
+                Resource page for NET encodings:  http://nsgreg.nga.mil/net
+   Definition:    The NSG Enterprise Thesaurus (NET) specifies a collection of semantic correlations
+                  between vocabulary terms from the NSG Enterprise Vocabulary (NEV) and other terminologies
+                  used in the characterization of Geospatial Intelligence (GEOINT), in order to support
+                  semantic interoperability between vocabularies for applications that implement
+                  terminology services, indexing, search, and navigation for GEOINT content.
+   Description:   A thesaurus is a controlled, structured resource in which vocabulary terms from two or
+                  more vocabularies are organized by pairwise semantic relations into term-matches that
+                  make explicit the relationship between the meanings of the vocabulary terms. The NET
+                  promotes improved understanding, search, retrieval, and utilization of resources
+                  (including documents, objects, and data instances) described using different
+                  vocabularies. The NET contains computer-interpretable correlations represented using the
+                  W3C Simple Knowledge Organization System (SKOS) and encoded in RDF/XML and N-Triples,
+                  thus providing a valuable reference for collaborative efforts across the NSG that require
+                  machine-processable semantics to enable linked open data stores of GEOINT data. The
+                  authority for management of the NSG Enterprise Thesaurus is established by NGA as a
+                  Standards Development Organization (SDO) and executed by the Geospatial Intelligence
+                  (GEOINT) Content Standards Board (GCSB), and the criteria for NET content are determined
+                  by NSG requirements.
+
+   Version Number: 1-1
+
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++-->
```

Figure 3 – Documentation for NET Content as a Registered Technical Artifact

```
<!--++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
+
+   NSG Enterprise Thesaurus (NET)
+
+   Namespace: http://api.nsgreg.nga.mil/vocabulary/net/
+   Resource:  http://nsgreg.nga.mil/doc/view?i=4627
+              NSG Enterprise Thesaurus (NET) Standard, Edition 1.0
+              NGA.STND.0070_1.0_NET
+   Supporting
+     Resources: NETX (ontology): http://api.nsgreg.nga.mil/ontology/netx/1.0
+                Resource page for NET encodings:  http://nsgreg.nga.mil/net
+   Definition:    The NSG Enterprise Thesaurus (NET) specifies a collection of semantic correlations
+                  between vocabulary terms from the NSG Enterprise Vocabulary (NEV) and other terminologies
+                  used in the characterization of Geospatial Intelligence (GEOINT), in order to support
+                  semantic interoperability between vocabularies for applications that implement
+                  terminology services, indexing, search, and navigation for GEOINT content.
+   Description:   A thesaurus is a controlled, structured resource in which vocabulary terms from two or
+                  more vocabularies are organized by pairwise semantic relations into term-matches that
+                  make explicit the relationship between the meanings of the vocabulary terms. The NET
+                  promotes improved understanding, search, retrieval, and utilization of resources
+                  (including documents, objects, and data instances) described using different
+                  vocabularies. The NET contains computer-interpretable correlations represented using the
+                  W3C Simple Knowledge Organization System (SKOS) and encoded in RDF/XML and N-Triples,
+                  thus providing a valuable reference for collaborative efforts across the NSG that require
+                  machine-processable semantics to enable linked open data stores of GEOINT data. The
+                  authority for management of the NSG Enterprise Thesaurus is established by NGA as a
+                  Standards Development Organization (SDO) and executed by the Geospatial Intelligence
+                  (GEOINT) Content Standards Board (GCSB), and the criteria for NET content are determined
+                  by NSG requirements.
+
+   Date of Last Change: 2018-10-01T12:06:17Z
+
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++-->
```

Figure 4 – Documentation for NET Content as a REST API Resource

5.5.4 Encodings for NET Information Model Concepts

5.5.4.1 Introduction

Section 5.3.2 of the NET Standard identifies the two basic types of information modeling concept in the NET information model: TermMatch and VocabularyTerm. Those concepts were defined in Table 5 and Table 6, respectively.

Encoding elements for the NET information model concepts are defined in this section. The table format used to document these encoding elements is as follows:

- The **Reference** column consists of a sequentially assigned, non-normative identifier of the encoding element that is provided for cross-referencing purposes. It may vary from version-to-version of this document.
- The **Modeling Concept** column specifies the class name, class attribute name, or class role name of the information modeling concept.
- The **Encoding Element** column specifies the SKOS (or other Semantic-Web standard) construct that shall be used to represent the corresponding NET Modeling Concept. Encoding elements are shown in the form used by the normative RDF/XML encoding of NET content. This includes the use of namespace abbreviations rather than fully specified IRIs (which are used by the N-Triples encoding).
- The **Cardinality of Element** column indicates the number of occurrences of the element that are permitted by the information model.
- The **Value Type** column indicates the modeling concept or datatype that is used to define the value(s) of the element.
- The **Notes** column contains comments, specifications of the actual value, or examples of values for the element.

5.5.4.2 RDF/XML Encoding for the Class TermMatch

The class TermMatch models a semantic relationship between a pair of vocabulary terms from different vocabularies that is based on the meanings of the two terms. Each encoding of a term-match in the NET content is an RDF triple consisting of a subject (the source vocabulary term), predicate (a semantic match relation), and an object (the target vocabulary term). The RDF/XML encoding of the class TermMatch is specified in Table 10 below, followed by an example.

Table 10 – Encoding Elements (RDF/XML) for the Class TermMatch

Reference	Modeling Concept	Encoding Element	Cardinality of Element	Value Type	Notes
1.	TermMatch	(See Notes)			The term-match is represented by an RDF triple, with components as specified on rows 3, 4, and 5. SOURCE: RDF 1.1 Concepts (Section 3.1)
2.	matchIRI	(See Notes)			Unsupported by RDF/XML[20]
3.	matchRelation	`IRI`	Exactly one		The matchRelation is the predicate component of the RDF triple representing the TermMatch. The IRI of the matchRelation is the property element of the triple in the RDF/XML encoding. The IRI is the identifier for a SemanticMatchRelation in SKOS or NETX, conditional upon the SKOS type of the linked VocabularyTerms (a SKOS mapping relation is used if both terms are SKOS Concepts).
4.	*Role name:* sourceTerm	[`skos:Concept` or `skos:ConceptScheme`] with attribute `rdf:about`	Exactly one	IRI (for source VocabularyTerm)	The sourceTerm is the subject component of the RDF triple representing the TermMatch. In the RDF/XML encoding, the subject component is represented by a node element using the SKOS type (*i.e.*, `Concept` or `ConceptScheme`) of the source VocabularyTerm together with the attribute `rdf:about`, whose value is the IRI of the source VocabularyTerm.
5.	*Role name:* targetTerm	`rdf:resource`	Exactly one	IRI (for target VocabularyTerm)	The targetTerm is the object component of the RDF triple representing the TermMatch. In the RDF/XML encoding, the object component is represented by the value of the attribute `rdf:resource`, on the property element; the value is the IRI of the target VocabularyTerm.
6.	*Role name:* reciprocalMatch	(See Notes)			Unsupported by RDF/XML. Implementation of reciprocalMatch is dependent upon the use of an application that assigns a unique identifier (matchIRI) for TermMatch, which then may be used to relate term-matches to one another.

[20] Identifiers for RDF triples are not defined in RDF/XML. Some applications using SPARQL or RDF Query Language may support the use of unique identifiers for RDF triples. Also see W3C RDF 1.1 N-Quads.

In RDF/XML encodings of NET content, IRIs are expressed using namespace abbreviations for the URI bases. XML namespace abbreviations are declared in the NET content RDF/XML encodings.

The attributes matchIRI and reciprocalMatch are dependent upon an RDF N-Quad implementation (or a functionally equivalent implementation). They are not used in the NET content but are defined in the information model for optional use in applications that support those capabilities.

An example of the RDF/XML encoding for TermMatch is presented in Figure 5, below, for the term-match relating the IGV term “Zip Code” to the NCV term “Postal Code”. The example encoding includes the enclosing rdf:RDF element and the namespace declarations (including declared abbreviations).

```
<rdf:RDF
    xml:base="http://api.nsgreg.nga.mil/vocabulary/net"
    xmlns="http://api.nsgreg.nga.mil/vocabulary/net/"
    xmlns:net="http://api.nsgreg.nga.mil/vocabulary/net/"
    xmlns:netx="http://api.nsgreg.nga.mil/ontology/netx/1.0/"
    xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
    xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
    xmlns:skos="http://www.w3.org/2004/02/skos/core#" >

    <skos:Concept rdf:about="http://api.nsgreg.nga.mil/vocabulary/inst-geo-service/zipCode">
        <skos:narrowMatch rdf:resource="http://api.nsgreg.nga.mil/vocabulary/ncv/postalCode"/>
    </skos:Concept>

</rdf:RDF>
```

Figure 5 – NET Content Encoding of a Term-match in RDF/XML

5.5.4.3 N-Triples Encoding for the Class TermMatch

The class TermMatch models a semantic relationship between a pair of vocabulary terms from different vocabularies that is based on the meanings of the two terms. Each encoding of a term-match in the NET content is an RDF triple consisting of a subject (the source vocabulary term), predicate (a semantic match relation), and an object (the target vocabulary term). The N-Triples encoding of the class TermMatch is specified in Table 11 below, followed by an example.

Table 11 – Encoding Elements (N-Triples) for the Class TermMatch

Reference	Modeling Concept	Encoding Element	Cardinality of Element	Value Type	Notes
1.	TermMatch	(See Notes)			The TermMatch is represented by an RDF triple, with components as specified on rows 3, 4, and 5. SOURCE: RDF 1.1 Concepts (Section 3.1)
2.	matchIRI	(See Notes)			Not implemented in NET content. Implementation of matchIRI is dependent upon the use of an N-Quad representation with the fourth component being an IRI assigned as a unique identifier for the TermMatch. [RDF 1.1 N-Quads]
3.	matchRelation	`IRI`	Exactly one		The IRI is the predicate component of the RDF triple representing the TermMatch. The IRI is the identifier for a SemanticMatchRelation in SKOS or NETX, conditional upon the SKOS type of the linked Vocabulary terms (a SKOS mapping relation is used if both terms are SKOS Concepts). The IRI is second (predicate) component in the N-Triples encoding of the TermMatch.
4.	*Role name:* sourceTerm	`IRI`	Exactly one		The IRI is the subject component of the RDF triple representing the TermMatch in the N-Triples. The IRI identifies the VocabularyTerm that is the source term of the TermMatch.
5.	*Role name:* targetTerm	`IRI`	Exactly one		The IRI is the object component of the RDF triple representing the TermMatch in the N-Triples. The IRI identifies the VocabularyTerm that is the target term of the TermMatch.
6.	*Role name:* reciprocalMatch	(See Notes)			Not implemented in NET content. Implementation of reciprocalMatch is dependent upon the use of an N-Quad representation that assigns a unique identifier (matchIRI) for TermMatch, which may then be used to relate term-matches to one another.

N-Triples encodings use full IRIs without abbreviations.

The attributes matchIRI and reciprocalMatch are dependent upon an RDF N-Quad implementation (or a functionally equivalent implementation). They are not used in the NET content but are defined in the information model for optional use in products that support those capabilities.

An example of a TermMatch in the N-Triples encoding is presented in Figure 6, below.

```
<http://api.nsgreg.nga.mil/vocabulary/inst-geo-service/zipCode> <http://www.w3.org/2004/02/skos/core#narrowMatch> <http://api.nsgreg.nga.mil/vocabulary/ncv/postalCode>
.
```

Figure 6 – NET Content Encoding of a Term-match in N-Triples

5.5.4.4 Encoding Requirements for VocabularyTerms

In the NET information model, the modeling concept VocabularyTerm represents vocabulary terms that are referenced by term-matches in the NET content. A term-match establishes a semantic relationship between vocabulary terms which are defined in previously established controlled vocabularies. Each TermMatch references a source term and target term using their IRIs as authoritatively published by the organization that manages the vocabularies.[21] Therefore, the class VocabularyTerm is not encoded in the NET content.

Vocabulary terms referenced by NET term-matches shall meet the following requirements:

a) Each vocabulary term shall be encoded as an instance (*i.e.*, with the type) of either SKOS Concept (`skos:Concept`) or SKOS Concept Scheme (`skos:ConceptScheme`).

b) Each vocabulary term shall have a unique IRI denoting the vocabulary term.

c) Each vocabulary term shall have a preferred human-readable name expressed as a character string in a natural language, with the language identified in the encoding.

   - Recommended encoding for the name property: `skos:prefLabel`
   - Recommended value type for encoding the name value: `rdf:PlainLiteral`

d) Each vocabulary term shall have a natural-language definition for the vocabulary term, expressed as a character string with the language of the definition identified in the encoding.

   - Recommended encoding for the definition property: `skos:definition`
   - Recommended value type for encoding the definition value: `rdf:PlainLiteral`

e) The natural language of the name and definition shall be identified using the IANA Language Subtag (using the annotation appropriate to the RDF concrete syntax in which the vocabulary is published).

The recommended representation for the required elements is that specified in the NCV Standard, Ed. 2.0.

Additional attribution (such as alternative labels for the vocabulary term) may also be defined by the controlled vocabulary in which the term is specified.

5.5.5 Encoding of Datatypes for TermMatch

5.5.5.1 Basic Datatype

The datatype IRI is represented using the XML datatype `xsd:anyURI`.

5.5.5.2 SemanticMatchRelation

The domain values of the enumeration SemanticMatchRelation are represented by either SKOS mapping properties or by NETX mapping properties, depending upon the SKOS construct used to represent the vocabulary terms in the term-match. The property is used as the predicate component in the RDF triple representing the term-match.

Table 12 presents the encodings for all enumerants of SemanticMatchRelation.

[21] In the RDF/XML encoding, IRIs are expressed using abbreviations for URI bases. The N-Triples encodings contain full IRIs.

Table 12 – Encoding for SemanticMatchRelation

Reference	NET Modeling Concept	Encoding Element	Notes
1.	exactTermMatch	(1) `skos:exactMatch` or (2) `netx:exactTermMatch`	Conditions for encodings (applies to all rows): (1) For term-matches in which both Vocabulary Terms are represented using `skos:Concept`); (2) For term-matches in which at least one of the Vocabulary Terms is represented using `skos:ConceptScheme`).
2.	closeTermMatch	(1) `skos:closeMatch` or (2) `netx:closeTermMatch`	(1) For term-matches in which both Vocabulary Terms are represented using `skos:Concept`); (2) For term-matches in which at least one of the Vocabulary Terms is represented using `skos:ConceptScheme`).
3.	broadTermMatch	(1) `skos:broadMatch` or (2) `netx:broadTermMatch`	(1) For term-matches in which both Vocabulary Terms are represented using `skos:Concept`); (2) For term-matches in which at least one of the Vocabulary Terms is represented using `skos:ConceptScheme`).
4.	narrowTermMatch	(1) `skos:narrowMatch` or (2) `netx:narrowTermMatch`	(1) For term-matches in which both Vocabulary Terms are represented using `skos:Concept`); (2) For term-matches in which at least one of the Vocabulary Terms is represented using `skos:ConceptScheme`).
5.	relatedTermMatch	(1) `skos:relatedMatch` or (2) `netx:relatedTermMatch`	(1) For term-matches in which both Vocabulary Terms are represented using `skos:Concept`); (2) For term-matches in which at least one of the Vocabulary Terms is represented using `skos:ConceptScheme`).

5.5.6 Technology-specific NET Content Encodings

5.5.6.1 Introduction

This section describes special characteristics of the two technology-specific encodings of the NET content.

5.5.6.2 RDF/XML Encoding

The NET Standard specifies a technology-specific encoding for the NET information model using RDF/XML.

The encoding of NET content in RDF/XML follows the general NET content encoding requirements, with the following technology-specific encodings applied:

a) In the RDF/XML encoding, the `rdf:RDF` element includes XML namespace declarations for the NET namespace and for the URI base abbreviations used by IRIs in the RDF/XML encoding.

b) In the RDF/XML encoding, the encoding of TermMatch implements the specification in Section 5.5.4.2.

c) In the RDF/XML encoding, the SKOS representation of the source term (as either a SKOS Concept or a SKOS Concept Scheme) determines the typing of the node element representing the subject of the RDF triple (see Figure 7 below).

   - NOTE: Each vocabulary term referenced by NET content shall belong to one of those two classes either directly or by inheritance. For example, vocabulary terms in NEV component vocabularies are declared using one of the NCVX classes ‘BasicVocabularyTerm’ or ‘ComplexVocabularyTerm’, which are subclasses of SKOS Concept and SKOS Concept Scheme, respectively. [NCV Standard, Ed. 2.0 (Annex D.2)]

d) In the RDF/XML encoding, where language tags are required, they shall be provided as the value of an RDF/XML annotation element (`xml:lang`) for the string-valued property, in order to indicate that the content is in English (language code “en”).

Figure 7, below, presents an example of the NET content encoding in RDF/XML. The content header is omitted, and only a small selection of term-matches is shown.

```
<rdf:RDF
    xml:base="http://api.nsgreg.nga.mil/vocabulary/net"
    xmlns="http://api.nsgreg.nga.mil/vocabulary/net/"
    xmlns:net="http://api.nsgreg.nga.mil/vocabulary/net/"
    xmlns:netx="http://api.nsgreg.nga.mil/ontology/netx/1.0/"
    xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
    xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
    xmlns:skos="http://www.w3.org/2004/02/skos/core#" >

    <skos:Concept rdf:about="http://api.nsgreg.nga.mil/vocabulary/inst-geo-service/Bathymetry
Area">
        <skos:exactMatch rdf:resource="http://api.nsgreg.nga.mil/vocabulary/ncv/DepthArea"/>
    </skos:Concept>

    <skos:Concept rdf:about="http://api.nsgreg.nga.mil/vocabulary/inst-geo-service/Berm">
        <skos:closeMatch rdf:resource="http://api.nsgreg.nga.mil/vocabulary/ncv/Embankment"/>
    </skos:Concept>

    <skos:Concept rdf:about="http://api.nsgreg.nga.mil/vocabulary/inst-geo-service/Berm">
        <skos:broadMatch
rdf:resource="http://api.nsgreg.nga.mil/vocabulary/ncv/EngineeredEarthwork"/>
    </skos:Concept>

    <skos:Concept rdf:about="http://api.nsgreg.nga.mil/vocabulary/inst-geo-service/Bridge">
        <skos:exactMatch rdf:resource="http://api.nsgreg.nga.mil/vocabulary/ncv/Bridge"/>
    </skos:Concept>

    <skos:Concept rdf:about="http://api.nsgreg.nga.mil/vocabulary/ncv/Bridge">
        <skos:exactMatch rdf:resource="http://api.nsgreg.nga.mil/vocabulary/inst-geo-
service/Bridge"/>
    </skos:Concept>

    <skos:Concept rdf:about="http://api.nsgreg.nga.mil/vocabulary/inst-geo-
service/bridgeVerticalClearanceOpen">
        <skos:closeMatch
rdf:resource="http://api.nsgreg.nga.mil/vocabulary/ncv/verticalClearanceOpen"/>
    </skos:Concept>

    <skos:Concept rdf:about="http://api.nsgreg.nga.mil/vocabulary/inst-geo-service/Building">
        <skos:narrowMatch rdf:resource="http://api.nsgreg.nga.mil/vocabulary/ncv/Building"/>
    </skos:Concept>

    <skos:Concept rdf:about="http://api.nsgreg.nga.mil/vocabulary/ncv/Building">
        <skos:broadMatch rdf:resource="http://api.nsgreg.nga.mil/vocabulary/inst-geo-
service/Building"/>
    </skos:Concept>.

    <skos:Concept rdf:about="http://api.nsgreg.nga.mil/vocabulary/inst-geo-service/zipCode">
        <skos:narrowMatch rdf:resource="http://api.nsgreg.nga.mil/vocabulary/ncv/postalCode"/>
    </skos:Concept>

    <skos:Concept rdf:about="http://api.nsgreg.nga.mil/vocabulary/inst-geo-
service/zipCodePlusFour">
        <skos:narrowMatch rdf:resource="http://api.nsgreg.nga.mil/vocabulary/ncv/postalCode"/>
    </skos:Concept>

</rdf:RDF>
```

Figure 7 – RDF/XML Encoding of NET Content (Excerpt)

5.5.6.3 N-Triples Encoding

The NET Standard specifies a technology-specific encoding for the NET information model using N-Triples. The W3C Recommendation RDF 1.1 N-Triples specifies a line-based, plain text format for encoding an RDF graph with each triple presented on a separate line followed by a period. N-Triples files do not contain special parsing instructions.

The encoding of NET content in N-Triples follows the general NET content encoding requirements, with the following technology-specific encodings applied:

a) Namespace abbreviations are not used in the N-Triples encoding; instead, fully-specified IRIs are used. For example: http://www.w3.org/2004/02/skos/core#broadMatch

b) In the N-Triples encoding, the encoding of TermMatch implements the specification in Section 5.5.4.3.

c) In the N-Triples encoding, where language tags are required or permitted, they shall be appended to the character string by using the '@' symbol, in order to indicate that their content is in English (language code "en").

Figure 8, below, presents an example of the NET content encoding in N-Triples. The content header is omitted, and only a small selection of term-matches is shown.

```
<http://api.nsgreg.nga.mil/vocabulary/ncv/baseElevation> <http://www.w3.org/2004/02/skos/core#exactMatch>
<http://api.nsgreg.nga.mil/vocabulary/inst-geo-service/elevationBase> .
<http://api.nsgreg.nga.mil/vocabulary/inst-geo-service/Bathymetry Area> <http://www.w3.org/2004/02/skos/core#exactMatch>
<http://api.nsgreg.nga.mil/vocabulary/ncv/DepthArea> .
<http://api.nsgreg.nga.mil/vocabulary/inst-geo-service/Berm> <http://www.w3.org/2004/02/skos/core#closeMatch>
<http://api.nsgreg.nga.mil/vocabulary/ncv/Embankment> .
<http://api.nsgreg.nga.mil/vocabulary/inst-geo-service/Berm> <http://www.w3.org/2004/02/skos/core#broadMatch>
<http://api.nsgreg.nga.mil/vocabulary/ncv/EngineeredEarthwork> .
<http://api.nsgreg.nga.mil/vocabulary/inst-geo-service/Borehole> <http://www.w3.org/2004/02/skos/core#closeMatch>
<http://api.nsgreg.nga.mil/vocabulary/ncv/Borehole> .
<http://api.nsgreg.nga.mil/vocabulary/ncv/Borehole> <http://www.w3.org/2004/02/skos/core#closeMatch>
<http://api.nsgreg.nga.mil/vocabulary/inst-geo-service/Borehole> .
<http://api.nsgreg.nga.mil/vocabulary/inst-geo-service/Bridge> <http://www.w3.org/2004/02/skos/core#exactMatch>
<http://api.nsgreg.nga.mil/vocabulary/ncv/Bridge> .
<http://api.nsgreg.nga.mil/vocabulary/ncv/Bridge> <http://www.w3.org/2004/02/skos/core#exactMatch>
<http://api.nsgreg.nga.mil/vocabulary/inst-geo-service/Bridge> .
<http://api.nsgreg.nga.mil/vocabulary/inst-geo-service/bridgeVerticalClearanceOpen> <http://www.w3.org/2004/02/skos/core#closeMatch>
<http://api.nsgreg.nga.mil/vocabulary/ncv/verticalClearanceOpen> .
<http://api.nsgreg.nga.mil/vocabulary/inst-geo-service/Building> <http://www.w3.org/2004/02/skos/core#narrowMatch>
<http://api.nsgreg.nga.mil/vocabulary/ncv/Building> .
<http://api.nsgreg.nga.mil/vocabulary/ncv/Building> <http://www.w3.org/2004/02/skos/core#broadMatch>
<http://api.nsgreg.nga.mil/vocabulary/inst-geo-service/Building> .
<http://api.nsgreg.nga.mil/vocabulary/inst-geo-service/bulkheadConstructionMaterial>
<http://www.w3.org/2004/02/skos/core#narrowMatch> <http://api.nsgreg.nga.mil/vocabulary/ncv/structMatType> .
<http://api.nsgreg.nga.mil/vocabulary/inst-geo-service/Cable> <http://www.w3.org/2004/02/skos/core#exactMatch>
<http://api.nsgreg.nga.mil/vocabulary/ncv/Cable> .
<http://api.nsgreg.nga.mil/vocabulary/ncv/Cable> <http://www.w3.org/2004/02/skos/core#exactMatch>
<http://api.nsgreg.nga.mil/vocabulary/inst-geo-service/Cable> .
<http://api.nsgreg.nga.mil/vocabulary/inst-geo-service/Campground> <http://www.w3.org/2004/02/skos/core#closeMatch>
<http://api.nsgreg.nga.mil/vocabulary/ncv/CampSite> .
<http://api.nsgreg.nga.mil/vocabulary/inst-geo-service/Campsite> <http://www.w3.org/2004/02/skos/core#closeMatch>
<http://api.nsgreg.nga.mil/vocabulary/ncv/CampSite> .
<http://api.nsgreg.nga.mil/vocabulary/ncv/CampSite> <http://www.w3.org/2004/02/skos/core#closeMatch>
<http://api.nsgreg.nga.mil/vocabulary/inst-geo-service/Campground> .
<http://api.nsgreg.nga.mil/vocabulary/ncv/CampSite> <http://www.w3.org/2004/02/skos/core#closeMatch>
<http://api.nsgreg.nga.mil/vocabulary/inst-geo-service/Campsite> .
<http://api.nsgreg.nga.mil/vocabulary/inst-geo-service/CanalLock> <http://www.w3.org/2004/02/skos/core#broadMatch>
<http://api.nsgreg.nga.mil/vocabulary/ncv/Lock> .
```

Figure 8 – N-Triples Encoding of NET Content (Excerpt)

6 Governance

6.1 Introduction

The management of this NET Standard conforms to the governance process established by NGA as a Standards Development Organization (SDO) and executed by the Geospatial Intelligence (GEOINT) Content Standards Board (GCSB). The scope, roles, and governance process of the GCSB are specified in the *GEOINT Content Standards Board (GCSB) Operations Guide*. Changes to the NET Standard and its associated NET content shall conform to that process. The GCSB is the community forum responsible for providing governance, community coordination, prioritization of content development, and notifications for the set of NGA-developed GEOINT Data Standards that define a common method for specifying and encoding geospatial intelligence and related geospatial information in the National System for Geospatial Intelligence (NSG).

The NET Standard and NET content evolve in response to GCSB management. The GCSB is responsible for approving changes, distributing change notifications, and publishing the NET Standard and the associated technical artifacts and other online resources containing the encodings of NET content for use by the U.S. Department of Defense (DoD), U.S. Intelligence Community (IC), and U.S. civil federal agencies.

The NET exists as an online information resource maintained by the U.S. National Center for Geospatial Intelligence Standards (NCGIS). The NET Standard and NET content in associated technical artifacts are published in the NSG-unique Standards Register of the NSG Standards Registry. NET content is also accessible through the REpresentational State Transfer (REST) API component of the NSG Standards Registry.

6.2 Official Publication of the NET Standard and NET Content

6.2.1 Introduction

The NET Standard and its associated NET content shall be published in accordance with the general process described in the GCSB Operations Guide, Section 2.3.5 (Implementation of Changes).

The specific managed content of the NET consists of:

a) technical artifacts published in the NSG-unique Standards Register of the NSG Standards Registry, and

b) online resources retrievable through the REST API component of the NSG Standards Registry.

All official publications of NET content shall conform to the information model specified in Section 5.3 of this NET Standard. All encodings shall conform to the SKOS representation and encoding for the NET content, as specified in Sections 5.4 and 5.5.

The NET Standard itself is published in the NSG-unique Standards Register of the NSG Standards Registry.

6.2.2 NET Content in the NET Register

The NET content is managed in the online NET Register (http://nsgreg.nga.mil/voc/registers.jsp?register=NET), which is one of a set of registers within the Vocabulary Registry of the NSG Standards Registry.[22] Entries in the NET Register are register items that document term-matches accompanied by their status and other metadata. The NET content evolves with NSG requirements.

A collection of all term-matches based on NET Register items whose status is ‘valid’ may be designated as a content baseline which is published as a normative technical artifact. The NET content is published as a set of normative technical artifacts in the NSG-unique Standards Register.

The content of the NET Register spans multiple content baselines. Register content is searchable and browsable in the Register user interface. Figure 9 on the next page shows the NSG Vocabulary Registry landing page with the NET Register selected from the left-hand menu. The Browse and Search capabilities of the NSG Standards Registry may be filtered by item type and date parameters to review the content of the current NET content baseline and/or prior content baselines.

[22] The NET Register conforms to the information model and management procedures established by ISO 19135, *Geographic information – Procedures for item registration*, which (1) specifies procedures to be followed in establishing, maintaining and publishing registers of unique, unambiguous, and permanent identifiers and meanings that are assigned to items of geographic information, and (2) specifies elements of information that are necessary to provide identification and meaning to the registered items and to manage the registration of those items.

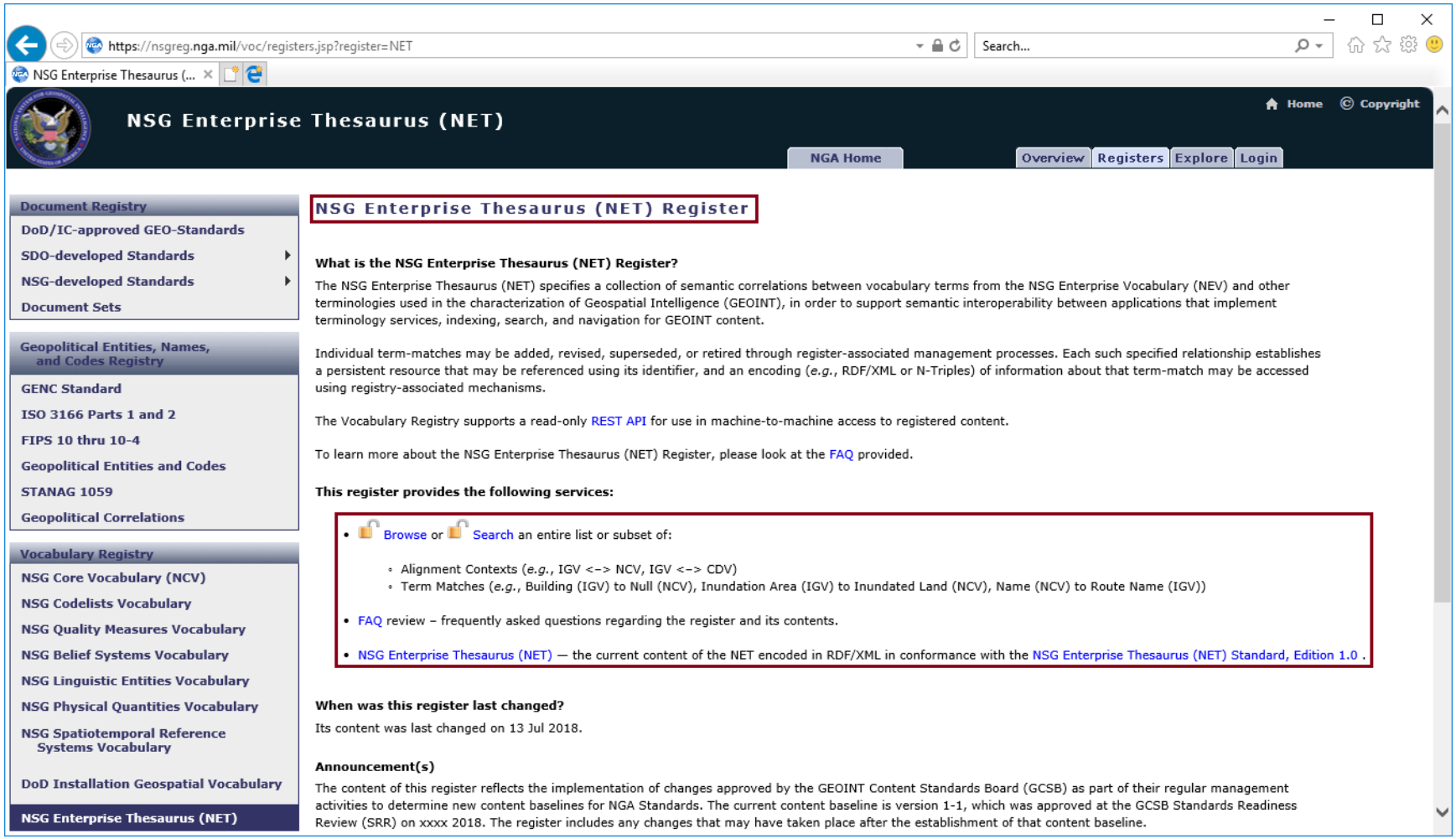

Figure 9 – NET Register Browse/Search Web Page

6.2.3 Publication of NET Content as a Normative Technical Artifact

The NET content is published as normative technical artifacts, which are registered files containing the NET content authorized for use as of a specified NET Standard edition or intermediate update and formatted in encodings as specified in Section 5.5 of this standard. For each such NET content baseline, two files encoding the NET content are published, one in RDF/XML format and one in N-Triples format. Each file contains the complete collection of NET term-matches for a specified baseline. These encoding files are published in the NSG-unique Standards Register of the NSG Standards Registry. A list of content baselines with versioned IRIs for their encoded content files is provided at http://nsgreg.nga.mil/net. The latest content baseline is always available at the following non-versioned URL: http://api.nsgreg.nga.mil/taxonomyvocabulary/net. HTTP content negotiation based on the Accept request-header field may be used to specify the media type (as 'application/rdf+xml' or 'application/n-triples') when resource retrieval is requested (the RDF/XML media type is the default).

6.2.4 Publication of NET Content as REST API-accessible Resources

Encodings of the NET content are also published as a set of online resources that may be accessed through the REST API component of the NSG Standards Registry. HTTP content negotiation based on the Accept request-header field may be used to specify the media type (as 'application/rdf+xml' or 'application/n-triples') when resource retrieval is requested.

RDF-based encodings of NET content may be accessed at:

- http://api.nsgreg.nga.mil/vocabulary/net?accept=application/rdf+xml
- http://api.nsgreg.nga.mil/vocabulary/net?accept=application/n-triples

In the absence of a client-specified media type the default media type ‘application/rdf+xml’ will be used for requests for complete NET content, *i.e.*:

- http://api.nsgreg.nga.mil/vocabulary/net

There are no subsets of RDF-based encodings of NET content.

Additional information from the NET Register, including metadata about term-matches, is available as REST API XML-based resources, as described in Annex C (informative).

Annex A – Conformance

(Normative)

A.1 Introduction

Conformance is the fulfilment of specified requirements.[23] Conformance with the NSG Enterprise Thesaurus (NET) Standard and associated NET content shall be determined based on the tests specified in this Annex. Any product claiming conformance with the NET in its entirety shall pass all the requirements specified in the abstract test suite in Section A.2.

A general explanation of conformance testing for the NET Standard and NET content is presented in this section, including relevant terminology. The conformance testing framework specified in Section A.2 is based on ISO 19105:2000 *Geographic information – Conformance and testing*. The definition of an abstract test suite for conformance testing appears in ISO 19105, together with an explanation of the testing framework. The format for conformance clauses is specified in ISO 19105, Annex A.

A.1.1 Terms and Definitions

A special terminology is used to describe the conformance testing framework. Terms that are defined in ISO 19105:2000 have a number in parentheses referring to the clause of that standard in which the term is defined.

Table 13 – Terms and Definitions for Conformance Testing

Term	Definition
abstract test case (ATC)	A generalized test for a particular requirement. (3.1) NOTE: An abstract test case is a formal basis for deriving executable test cases. One or more test purposes are encapsulated in the abstract test case. An abstract test case is independent of both the implementation and the values. It should be complete in the sense that it is sufficient to enable a test verdict to be assigned unambiguously to each potentially observable test outcome (*i.e*., sequence of test events).
abstract test module (ATM)	A set of related **abstract test cases**. (3.3) NOTE: Abstract test modules may be nested in a hierarchical way.
abstract test suite (ATS)	An **abstract test module** specifying all the requirements to be satisfied for conformance. (3.4)
basic test	An initial **capability test** intended to identify clear cases of non-conformance. (3.6) NOTE: Basic tests may be used to determine whether to conduct further tests.
capability test	A test designed to determine whether an **implementation** under test conforms to a particular characteristic of a standard as described in the test purpose. (3.7) NOTE: Capability tests check that the capabilities claimed in an implementation conformance statement (ICS) are consistent with the observable capabilities of the implementation under test.
conformance	The fulfilment of specified requirements. (3.8) NOTE: Conformance may be claimed for data or software or services or for specifications including any profile or functional standard.
conformance testing	The testing of a product to determine the extent to which the product is a conforming **implementation**. (3.11)

[23] ISO 19105:2000 *Geographic information – Conformance and testing*.

contains	Includes a representation of the NET content. NOTE: A product may contain the NET content either directly (for example, by installing the NET content in one of its two official encodings), or by reference (for example, by adding the mapping relations declared in NET term-matches to representations of the referenced Vocabulary Terms).
implementation	A realization of a specification. (3.18) NOTE: In the context of the ISO geographic information standards, this includes specifications of geographic information services and datasets.
implementation conformance statement (ICS)	A statement of the options which have been implemented. (3.19) NOTE: This will allow the implementation to be tested for conformance against the relevant requirements, and against those requirements only. This statement shall contain only options within the framework of requirements specified in the relevant geographic information standards.
product	Data or software or a service. (3.8)
verdict	The result of a test. (6.4.4) NOTE: The value of a test verdict is one of: *pass*, *fail*, or *inconclusive*. Verdict criteria are specified by an abstract test case.

A.1.2 Conformance Testing Methodology

Conformance testing for the NET is specified by this abstract test suite (ATS).

An ATS comprises all the abstract test cases needed to produce an overall verdict about the conformance of a candidate product. Abstract test cases may be collected in a set of related tests called an abstract test module. Abstract test modules may be nested. An abstract test suite includes test modules and other test cases arranged in a hierarchy of conformance tests.

Each abstract test case is designed to test a candidate product for conformance to a specific requirement. A test case has several components:

a) A test-case identifier;

b) A stated test purpose that is a precise description of the test objective and also indicates whether the requirement being tested is mandatory, conditional, or optional;

c) A description of the test method, specifying the test criteria that shall be used to determine the test verdict. A test may evaluate a multi-part requirement. The method indicates the way in which the test shall be conducted (*e.g.*, manual or automated). The test method may reference other clauses in the test suite.

d) References to one or more sections in the standard that identify the requirements addressed by the test.

e) The test type (either a basic test or a capability test).

Mandatory requirements are those which shall be observed in all cases. Conditional requirements shall be observed if the conditions set out in the specification apply. Optional requirements may be selected to suit the implementation, provided that any requirements applicable to the option are observed.[24]

In addition to an ATS, testing requires an implementation conformance statement (ICS) that declares which capabilities have been implemented for the product. This is especially important when there are options that may be implemented (or not), in order to evaluate the conformance of a particular implementation against the relevant requirements.

There is one class of conformance testing for the NET content, which tests for use of the complete NET content by a specified product.

Products that claim conformance with the NET content shall support either the RDF/XML encoding or the N-Triples encoding of the NET content, or both.

[24] ISO 19105:2000, Section 5.3.

The ATS for the NET content (Section A.2) specifies conformance evaluation of a product using the NET content as a whole, that is, with all of the content specified in an identified content baseline in the RDF/XML encoding and/or the N-Triples encoding.

An implementation conformance statement (ICS) for a product to be tested for conformance to the NET content shall contain the following information regarding the capabilities that have been implemented for the product:

I. Identification of the NET content baseline (and thus the NET Standard edition) to which the product conforms.

II. Statement of whether the product conforms to the RDF/XML or N-Triples encoding (or both).

III. Statement of whether the product uses NET content from a locally installed copy(ies) of the officially published technical artifacts or in some other form of access or implementation.

IV. Explanation of how to acquire authorized access to the system(s) where the product is installed, if needed to test the product.

Abstract test cases may be automated for performance by a software system. Manual testing may be necessary when human judgment is required or when automated testing is too complex.

A.1.3 Logical Structure of the Abstract Test Suite for NET Conformance

The abstract test suite for NET conformance contains four top-level test modules, each of which contains multiple test modules and/or test cases. The structure of the test suite is depicted in Figure 10.

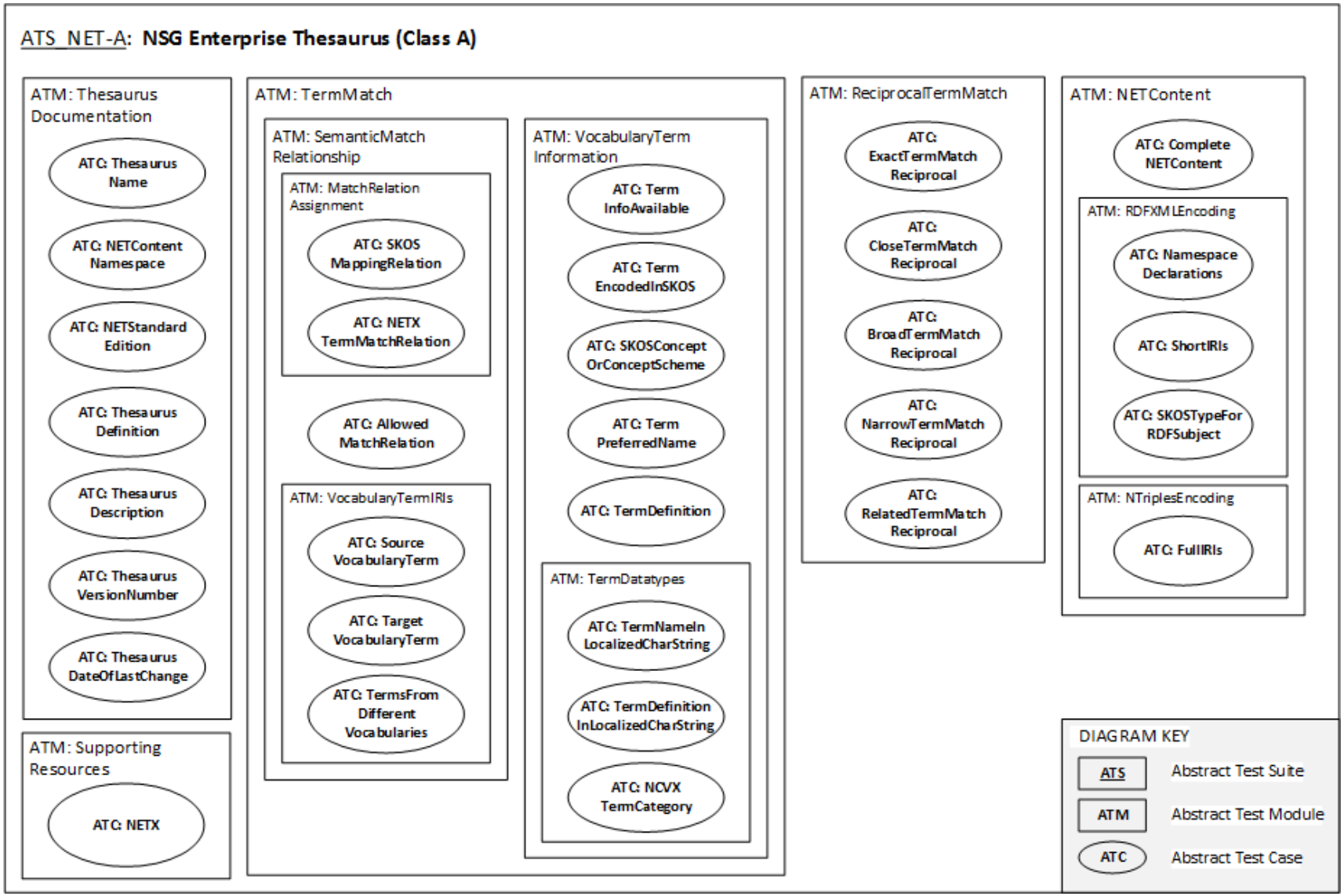

Figure 10 – Structure of Abstract Test Suite for NET Content

A.2 Abstract Test Suite for the NSG Enterprise Thesaurus (NET) Content

a) Test identifier: ATS_NET-A

b) Test purpose: Verify the conformance of the product with NET content as specified by the NET Standard. (**Mandatory**)

c) Test method: Inspect the product to determine that it is consistent with the required thesaurus documentation (A.2.1), thesaurus dependencies (A.2.2), term-matches (A.2.3), reciprocal term-match constraints (A.2.4), and NET content encoding in RDF (A.2.5), in accordance with the requirements in the NET Standard and the NET content specified in the Implementation Conformance Statement (ICS) for the product.

d) Reference: NSG Enterprise Thesaurus (NET) Standard, Section 5; NET content resources.

e) Test type: Basic

NOTE: If an information construct from the NET Standard is employed within a product, then the meaning and structure of that construct shall be preserved, and information regarding the corresponding construct shall be exactly as specified in the NET Standard. If NET content is employed within a product, then the meaning and structure of the content shall be consistent with the NET content in one of its official encodings.

A.2.1 Test Module for Thesaurus Documentation

a) Test identifier: ThesaurusDocumentation

b) Test purpose: Verify the conformance of the product with required documentation of the NET content as specified in the NET Standard, with correct values for the NET content resource used by the product as specified in the ICS. (**Mandatory**)

c) Test method: Inspect the product in order to determine that it contains the required information from the resource documentation properties specified in the NET Standard, with correct values for the NET content version specified in the ICS (A.2.1.1, A.2.1.2, A.2.1.3, A.2.1.4, A.2.1.5, A.2.1.6, and A.2.1.7).

NOTE: The product may contain the required information specified in this module by using at least one of the following methods: (i) by providing users with access to the header information in the NET content encoding file; (ii) by exposing the information in the user interface of the product; or (iii) by recording the information in a vocabulary resource catalogue available to users of the product.

d) Reference: NET Standard (Section 5.4.4 and Section 5.5.3); NET content header.

e) Test type: Basic

A.2.1.1 Test Case for Thesaurus Name

a) Test identifier: ThesaurusName

b) Test purpose: Verify the conformance of the product with documentation of the name for the NSG Enterprise Thesaurus. (**Mandatory**)

c) Test method: Inspect the product in order to determine that it contains (by one of the methods specified for test module A.2.1) the name of the thesaurus as specified in the NET content header of the encoding file specified in the ICS.

d) Reference: NET Standard (Section 5.4.4 (a), Section 5.5.3 (Figure 3 and Figure 4)); NET content header.

e) Test type: Basic

A.2.1.2 Test Case for NET Content Namespace

a) Test identifier: NETContentNamespace

b) Test purpose: Verify the conformance of the product with documentation of the namespace for the NET content resource. (**Mandatory**)

c) Test method: Inspect the product in order to determine that it contains (by one of the methods specified for test module A.2.1) the documentation of the namespace for the NET content with which the product claims conformance as specified in the ICS.

d) Reference: NET Standard (Section 5.4.4 (b), Section 5.5.3 (Figure 3 and Figure 4)); NET content header.

e) Test type: Basic

A.2.1.3 Test Case for NET Standard Edition

a) Test identifier: NETStandardEdition

b) Test purpose: Verify the conformance of the product with the documentation of the edition of the NET Standard. (**Mandatory**)

c) Test method: Inspect the product in order to determine that it contains (by one of the methods specified for test module A.2.1) the name and URL for the edition of the NET Standard with which the product claims conformance as specified in the ICS.

d) Reference: NET Standard (Section 5.4.4 (c), Section 5.5.3 (Figure 3 and Figure 4)); NET content header.

e) Test type: Basic

A.2.1.4 Test Case for Thesaurus Definition

a) Test identifier: ThesaurusDefinition

b) Test purpose: Verify the conformance of the product with documentation of the definition of the NET content resource. (**Mandatory**)

c) Test method: Inspect the product in order to determine that it contains (by one of the methods specified for test module A.2.1) the definition for the NET content resource with which the product claims conformance as specified in the ICS.

d) Reference: NET Standard (Section 5.4.4 (e), Section 5.5.3 (Figure 3 and Figure 4)); NET content header.

e) Test type: Basic

A.2.1.5 Test Case for Thesaurus Description

a) Test identifier: ThesaurusDescription

b) Test purpose: Verify the conformance of the product with documentation of the description for the NET content resource. (**Mandatory**)

c) Test method: Inspect the product in order to determine that it contains (by one of the methods specified for test module A.2.1) the description for the NET content resource with which the product claims conformance as specified in the ICS.

d) Reference: NET Standard (Section 5.4.4 (f), Section 5.5.3 (Figure 3 and Figure 4)); NET content header.

e) Test type: Basic

A.2.1.6 Test Case for Thesaurus Version Number

a) Test identifier: ThesaurusVersionNumber

b) Test purpose: Verify the conformance of the product with documentation of the version number for the NET content resource with which the product claims conformance. (Conditional)

c) Test method: In the case where the ICS specifies conformance with a registered technical-artifact encoding (“baseline”) of the NET content, inspect the product in order to determine that it contains (by one of the methods specified for test module A.2.1) the version number for the NET content resource with which the product claims conformance.

d) Reference: NET Standard (Section 5.4.4 (g), Section 5.5.3 (Figure 3 and Figure 4)); NET content header.

e) Test type: Basic

A.2.1.7 Test Case for Thesaurus Date of Last Change

a) Test identifier: ThesaurusDateOfLastChange

b) Test purpose: Verify the conformance of the product with documentation of the date of last change for the NET content resource with which the product claims conformance. (Conditional)

c) Test method: In the case where the ICS specifies conformance with a REST API-retrieved encoding of the NET content, inspect the product in order to determine that it contains (by one of the methods specified for test module A.2.1) the date of last change for the NET content resource with which the product claims conformance.

d) Reference: NET Standard (Section 5.4.4 (h), Section 5.5.3 (Figure 3 and Figure 4)); NET content header.

e) Test type: Basic

A.2.2 Test Module for Supporting Resources

a) Test identifier: SupportingResources

b) Test purpose: Verify the conformance of the product with all required supporting resources as specified in the NET Standard and the NET content resource with which the product claims conformance. (**Mandatory**)

c) Test method: Inspect the product in order to determine that it contains the required supporting resources specified in the NET Standard and documented in the NET content resource specified in the ICS (A.2.2.1).

NOTE: The product shall contain the required resource(s) specified in this test module by using one of the following methods to provide the product with access to the resource: (i) Web-retrievable access, or (ii) local installation of the content of the resource; in either case, the content of the resource must be available to the product in operation.

d) Reference: NET Standard (Section 5.4.4 (d), Section 5.5.3 (Figure 3 and Figure 4)); NET content header.

e) Test type: Basic

A.2.2.1 Test Case for NETX Ontology

a) Test identifier: NETX

b) Test purpose: Verify the availability to the product of the NETX utility ontology specified in the NET Standard and NET content resource with which the product claims conformance. (**Mandatory**)

c) Test method: Inspect the product in order to determine that it has access to the version of the NETX ontology specified in the NET Standard and the NET content resource specified in the ICS, either by (i) online Web access, or (ii) local installation of a copy of the ontology.

d) Reference: NET Standard (Section 5.4.4 (d), Section 5.5.3 (Figure 3 and Figure 4), Section 5.5.5.2, and Annex D); NET content header.

e) Test type: Basic

A.2.3 Test Module for Term-matches

a) Test identifier: TermMatch

b) Test purpose: Verify the conformance of the product with the structural elements required for term-matches in the NET content and with the required information for vocabulary terms linked by the term-matches. (**Mandatory**)

c) Test method: Inspect the product to determine that it contains term-matches with the required structural elements, including: term-match relations from SKOS and NETX (A.2.3.1; A.2.3.2), and IRIs for correlated vocabulary terms referenced in different external vocabularies (A.2.3.3); and that the product has access to required information about the referenced vocabulary terms (A.2.3.4).

d) Reference: NET Standard (Section 5.3, Section 5.4, Section 5.5); NET content.

e) Test type: Basic

A.2.3.1 Test Module for Semantic Match Relationships

a) Test identifier: SemanticMatchRelationship

b) Test purpose: Verify the conformance of the product with the structural elements required for term-matches in the NET content, as specified in the NET Standard. (**Mandatory**)

c) Test method: Inspect the product to determine that it contains term-matches with the required structural elements, including: term-match relations from SKOS and NETX (A.2.3.1; A.2.3.2), and IRIs for the correlated vocabulary terms referenced in different external vocabularies (A.2.3.3).

d) Reference: NET Standard (Section 5.3, Section 5.4, Section 5.5); NET content.

e) Test type: Basic

A.2.3.1.1 Test Module for Match Relation Assignment

a) Test identifier: MatchRelationAssignment

b) Test purpose: Verify the conformance of the product with the use of SKOS mapping relations or NETX term-match relations to encode term-match relations as specified in the NET Standard. (**Mandatory**)

c) Test method: Verify that: (1) each term-match that relates two vocabulary terms which are both represented (in the vocabularies where they are defined) using SKOS Concept (`skos:Concept`) has a SKOS mapping relation (a sub-property of `skos:mappingRelation`) as its term-match relation; (2) each term-match that relates two vocabulary terms at least one of which is represented (in the vocabularies where they are defined) using SKOS Concept Scheme (`skos:ConceptScheme`) has an NETX semantic relation term-match relation.

d) Reference: NET Standard (Section 5.5.5.2, Table 12; Annex D); NET content.

e) Test type: Basic

A.2.3.1.1.1 Test Case for SKOS Semantic Relation

a) Test identifier: SKOSMappingRelation

b) Test purpose: Verify the conformance of the product with the use of a SKOS mapping relation to encode the term-match relation between two vocabulary terms if both are represented (in the vocabularies where they are defined) as instances of SKOS Concept. (Conditional)

c) Test method: Verify that each term-match that relates two vocabulary terms which are both represented (in the vocabularies where they are defined) using SKOS Concept (`skos:Concept`) is related using a SKOS mapping relation (a sub-property of `skos:mappingRelation`) as its term-match relation.

d) Reference: NET Standard (Section 5.5.5.2, Table 12); NET content.

e) Test type: Basic

A.2.3.1.1.2 Test Case for NETX Term-match Relation

a) Test identifier: NETXTermMatchRelation

b) Test purpose: Verify the conformance of the product with the use of an NETX mapping relation to encode the term-match relation between two vocabulary terms if at least one is represented (in the vocabularies where they are defined) as an instance of SKOS Concept Scheme. (Conditional)

c) Test method: Verify that each term-match that relates two vocabulary terms at least one of which is represented (in the vocabularies where they are defined) using SKOS Concept Scheme (`skos:ConceptScheme`) has an NETX semantic relation as its term-match relation

d) Reference: NET Standard (Section 5.5.5.2, Table 12; Annex D); NET content.

e) Test type: Basic

A.2.3.1.2 Test Case for Allowed Match Relations

a) Test identifier: AllowedMatchRelation

b) Test purpose: Verify the conformance of the product with the allowed set of term-matching relations from SKOS and NETX, as specified in the NET Standard. (**Mandatory**)

c) Test method: Verify that the term-match relation in each NET content term-match is one of: (1) the SKOS mapping relations exactMatch, closeMatch, broadMatch, narrowMatch, relatedMatch; or (2) the NETX relations exactTermMatch, closeTermMatch, broadTermMatch, narrowTermMatch, relatedTermMatch.

d) Reference: SKOS Reference, Section 10; NET Standard (5.5.5.2, Table 12; Annex D); NET content.

e) Test type: Basic

A.2.3.1.3 Test Module for Vocabulary Term IRIs

a) Test identifier: VocabularyTermIRIs

b) Test purpose: Verify the conformance of the product with the use of IRIs to reference correlated vocabulary terms in term-matches, as specified in the NET Standard. (**Mandatory**)

c) Test method: Inspect the product in order to determine that each term-match uses valid IRIs to reference the source and target vocabulary terms in the vocabularies where they are defined.

d) Reference: NET Standard (Section 5.4.3, Section 5.5.4.4); NET content

e) Test type: Basic

A.2.3.1.3.1 Test Case for Source Vocabulary Term

a) Test identifier: SourceVocabularyTerm

b) Test purpose: Verify the conformance of the product with the use of a valid IRI to reference the source vocabulary term of each term-match, as specified in the NET Standard. (**Mandatory**)

c) Test method: Inspect the product in order to determine that each term-match uses a valid IRI to reference the source vocabulary term in the vocabulary where it is defined.

d) Reference: NET Standard (Section 5.4.3, Section 5.5.4.4); NET content.

e) Test type: Basic

A.2.3.1.3.2 Test Case for Target Vocabulary Term

a) Test identifier: TargetVocabularyTerm

b) Test purpose: Verify the conformance of the product with the use of a valid IRI to reference the target vocabulary term of each term-match, as specified in the NET Standard. (**Mandatory**)

c) Test method: Inspect the product in order to determine that each term-match uses a valid IRI to reference the target vocabulary term in the vocabulary where it is defined.

d) Reference: NET Standard (Section 5.4.3, Section 5.5.4.4); NET content.

e) Test type: Basic

A.2.3.1.3.3 Test Case for Terms from Different Vocabularies

a) Test identifier: TermsFromDifferentVocabularies

b) Test purpose: Verify the conformance of the product with the requirement that the source and target vocabulary terms correlated by a term-match belong to different vocabularies. (**Mandatory**)

c) Test method: Inspect the product in order to determine that the source and target vocabulary terms correlated by each term-match belong to different vocabularies (*i.e.*, different vocabulary namespaces having different IRIs).

d) Reference: NET Standard (Section 5.5.4); NET content.

e) Test type: Basic

A.2.3.2 Test Module for Vocabulary Term Information

a) Test identifier: VocabularyTermInformation

b) Test purpose: Verify the conformance of the product with the set of requirements for vocabulary terms referenced by term-matches, as specified in the NET Standard. (**Mandatory**)

c) Test method: Inspect the product in order to determine that it has the required information about vocabulary terms correlated in term-matches, as specified in the NET Standard.

d) Reference: NET Standard (Section 5.5.4.4).

e) Test type: Basic

A.2.3.2.1 Test Case for Term Information Availability

a) Test identifier: TermInfoAvailable

b) Test purpose: Verify the conformance of the product with availability of required information for vocabulary terms correlated by term-matches, as specified in the NET Standard. (**Mandatory**)

c) Test method: Inspect the product in order to determine that it has access to the required information about vocabulary terms correlated in term-matches, whether through online retrieval of vocabulary information or from a local copy.

d) Reference: NET Standard (Section 5.5.4.4).

e) Test type: Basic

A.2.3.2.2 Test Case for Term Encoding in SKOS

a) Test identifier: TermEncodedInSKOS

b) Test purpose: Verify the conformance of the product with the requirement that all vocabulary terms referenced by term-matches shall be encoded in SKOS, as specified in the NET Standard. (**Mandatory**)

c) Test method: Inspect the product in order to determine that all vocabulary terms referenced by term-matches in the specified NET content are represented using SKOS in the vocabulary where they are defined.

d) Reference: NET Standard (Section 5.5.4.4); NET content (by IRI reference).

e) Test type: Basic

A.2.3.2.3 Test Case for SKOS Concept or Concept Scheme

a) Test identifier: SKOSConceptOrConceptScheme

b) Test purpose: Verify the conformance of the product with the requirement that each vocabulary term referenced by a term-match shall be an instance of either SKOS Concept or SKOS Concept Scheme, as specified in the NET Standard. (**Mandatory**)

c) Test method: Inspect the product in order to determine that each vocabulary term referenced by a term-match is an instance (*i.e.*, has the type) of either SKOS Concept (`skos:Concept`) or SKOS Concept Scheme (`skos:ConceptScheme`), whether directly or by inheritance, based on its encoding in the vocabulary where it is defined.

d) Reference: NET Standard (Section 5.5.4.4 (a)); SKOS Reference.

e) Test type: Basic

A.2.3.2.4 Test Case for Vocabulary Term Preferred Name

a) Test identifier: TermPreferredName

b) Test purpose: Verify the conformance of the product with the requirement that each vocabulary term referenced by a term-match shall have a preferred human-readable name expressed in an identified natural language, as specified in the NET Standard. (**Mandatory**)

c) Test method: Inspect the product in order to determine that, for each vocabulary term referenced by a term-match, the product has access to the preferred human-readable name for the term, expressed in an identified natural language, in the vocabulary where it is defined.

d) Reference: NET Standard (Section 5.5.4.4 (c)).

e) Test type: Basic

A.2.3.2.5 Test Case for Vocabulary Term Definition

a) Test identifier: TermDefinition

b) Test purpose: Verify the conformance of the product with the requirement that each vocabulary term referenced by a term-match shall have a human-readable definition expressed in an identified natural language, as specified in the NET Standard. (**Mandatory**)

c) Test method: Inspect the product in order to determine that, for each vocabulary term referenced by a term-match, the product has access to the human-readable definition for the term, expressed in an identified natural language, in the vocabulary where it is defined.

d) Reference: NET Standard (Section 5.5.4.4 (d)).

e) Test type: Basic

A.2.3.2.6 Test Module for Vocabulary Term Datatypes

a) Test identifier: TermDatatypes

b) Test purpose: Verify the conformance of the product with the recommended or required datatypes for vocabulary information, as specified in the NET Standard. (**Mandatory**)

c) Test method: Inspect the product in order to determine that the required information about vocabulary terms referenced by term-matches uses the recommended or required datatypes, as specified in the NET Standard.

d) Reference: NET Standard (Section 5.5.4.4).

e) Test type: Basic

A.2.3.2.6.1 Test Case for Term Name in Localized Character String

a) Test identifier: TermNameInLocalizedCharString

b) Test purpose: Verify the conformance of the product with access to vocabulary term names in a localized character string with the natural language identified by an IANA language subtag. (**Mandatory**)

c) Test method: Inspect the product in order to determine that the vocabulary term names available to the product are expressed in localized character strings using the recommended datatype `rdf:PlainLiteral` (or a comparable datatype) with the language identified by the required IANALanguageSubtag datatype. The IANALanguageSubtag value must belong to the set of two-character, lowercase values specified in BCP 47.

d) Reference: NET Standard (Section 5.5.4.4 (c, e), Section 5.3.3.5); vocabulary content retrievable using the IRI.

e) Test type: Basic

A.2.3.2.6.2 Test Case for Term Definition in Localized Character String

a) Test identifier: TermDefinitionInLocalizedCharString

b) Test purpose: Verify the conformance of the product with access to vocabulary term definitions in a localized character string with the natural language identified by an IANA language subtag. (**Mandatory**)

c) Test method: Inspect the product in order to determine that the vocabulary term definitions available to the product are expressed in localized character strings using the recommended datatype `rdf:PlainLiteral` (or a comparable datatype) with the language identified by the required IANALanguageSubtag datatype. The IANALanguageSubtag value must belong to the set of two-character, lowercase values specified in BCP 47.

d) Reference: NET Standard (Section 5.5.4.4 (d, e), Section 5.3.3.5); vocabulary content retrievable using the IRI.

e) Test type: Basic

A.2.3.2.6.3 Test Case for NCVX Term Category

a) Test identifier: NCVXTermCategory

b) Test purpose: Verify that, if a term-match references a vocabulary term that belongs to an NEV component vocabulary, then the product has access to the TermCategoryType information for the referenced vocabulary term. (Conditional)

c) Test method: Inspect the product in order to determine that the information available to the product for a referenced vocabulary term from an NEV component vocabulary includes the term category identified by a value from the TermCategoryType datatype.

d) Reference: NET Standard (Section 5.3.3.6, Section 5.5.4.4); vocabulary content retrievable using the IRI.

e) Test type: Basic

A.2.4 Test Module for Reciprocal Term Matches

a) Test identifier: ReciprocalTermMatch

b) Test purpose: Verify the conformance of the product with the required constraints on reciprocal term-match relations, as specified in the information model of the NET Standard. (**Mandatory**)

c) Test method: Inspect the product in order to determine that if the NET content contains a term-match between two vocabulary terms as source term and target term, and also contains a second term-match in which the same two vocabulary terms have the source and target terms reversed, then the term-match relations of the two term-matches conform to the constraints on reciprocal term-matches, as specified in the NSG thesaurus information model of the NET Standard. (A.2.4.1, A.2.4.2, A.2.4.3, A.2.4.4, A.2.4.5)

d) Reference: NET Standard (Section 5.3.2 (Figure 1; Table 5 (row 6))).

e) Test type: Basic

A.2.4.1 Test Case for Exact Term-match Reciprocal

a) Test identifier: ExactTermMatchReciprocal

b) Test purpose: Verify the conformance of the product with the constraint that the reciprocal term-match relation of exactTermMatch is exactTermMatch. (Conditional)

c) Test method: Inspect the product in order to determine that if it contains a term-match between a source term and a target term, and another term-match in which the source/target roles of those terms are reversed, then if the term-match relation of the first term-match is exactTermMatch, then the term-match relation of the second term-match must also be exactTermMatch.

d) Reference: NET Standard (Section 5.3.2 (Figure 1; Table 5 (row 6))).

e) Test type: Basic

A.2.4.2 Test Case for Close Term-match Reciprocal

a) Test identifier: CloseTermMatchReciprocal

b) Test purpose: Verify the conformance of the product with the constraint that the reciprocal term-match relation of closeTermMatch is closeTermMatch. (Conditional)

c) Test method: Inspect the product in order to determine that if it contains a term-match between a source term and a target term, and another term-match in which the source/target roles of those terms are reversed, then if the term-match relation of the first term-match is closeTermMatch, then the term-match relation of the second term-match must also be closeTermMatch.

d) Reference: NET Standard (Section 5.3.2 (Figure 1; Table 5 (row 6))).

e) Test type: Basic

A.2.4.3 Test Case for Broad Term-match Reciprocal

a) Test identifier: BroadTermMatchReciprocal

b) Test purpose: Verify the conformance of the product with the constraint that the reciprocal term-match relation of broadTermMatch is narrowTermMatch. (Conditional)

c) Test method: Inspect the product in order to determine that if it contains a term-match between a source term and a target term, and another term-match in which the source/target roles of those terms are reversed, then if the term-match relation of the first term-match is broadTermMatch, then the term-match relation of the second term-match must be narrowTermMatch.

d) Reference: NET Standard (Section 5.3.2 (Figure 1; Table 5 (row 6))).

e) Test type: Basic

A.2.4.4 Test Case for Narrow Term-match Reciprocal

a) Test identifier: NarrowTermMatchReciprocal

b) Test purpose: Verify the conformance of the product with the constraint that the reciprocal term-match relation of narrowTermMatch is broadTermMatch. (Conditional)

c) Test method: Inspect the product in order to determine that if it contains a term-match between a source term and a target term, and another term-match in which the source/target roles of those terms are reversed, then if the term-match relation of the first term-match is narrowTermMatch, then the term-match relation of the second term-match must be broadTermMatch.

d) Reference: NET Standard (Section 5.3.2 (Figure 1; Table 5 (row 6))).

e) Test type: Basic

A.2.4.5 Test Case for Related Term-match Reciprocal

a) Test identifier: RelatedTermMatchReciprocal

b) Test purpose: Verify the conformance of the product with the constraint that the reciprocal term-match relation of relatedTermMatch is relatedTermMatch. (Conditional)

c) Test method: Inspect the product in order to determine that if it contains a term-match between a source term and a target term, and another term-match in which the source/target roles of those terms are reversed, then if the term-match relation of the first term-match is relatedTermMatch, then the term-match relation of the second term-match must also be relatedTermMatch.

d) Reference: NET Standard (Section 5.3.2 (Figure 1; Table 5 (row 6))).

e) Test type: Basic

A.2.5 Test Module for NET Content

a) Test identifier: NETContent

b) Test purpose: Verify the conformance of the product with the requirement to include the complete content of the NET content, consistent with the specified encoding format. (**Mandatory**)

c) Test method: Inspect the product in order to determine that: (1) the complete NET content specified in the ICS is available to the product (A.2.5.1); (2) the RDF/XML encoding of the NET content conforms to the specification in the NET Standard (A.2.5.2); (3) the N-Triples encoding of the NET content conforms to the specification in the NET Standard (A.2.5.3).

d) Reference: NET Standard (Section 5.5, Section 5.5.4.2, Section 5.5.4.3)

e) Test type: Basic

A.2.5.1 Test Case for Complete NET Content

a) Test identifier: CompleteNETContent

b) Test purpose: Verify the conformance of the product with the requirement to include the complete content of the NET content. (**Mandatory**)

c) Test method: Inspect the product in order to determine that it contains the complete content of the NET content resource specified in the ICS.

d) Reference: NET Standard (Section 5.5)

e) Test type: Basic

A.2.5.2 Test Module for RDF/XML Technology-specific Encoding

a) Test identifier: RDFXMLEncoding

b) Test purpose: Verify the conformance of the product with the technology-specific requirements of the RDF/XML encoding of the NET content, as specified in the NET Standard and NET content. (Conditional on the product using the RDF/XML encoding of the NET content)

c) Test method: Inspect the product in order to determine that it conforms to the technology-specific requirements of the RDF/XML encoding of the NET content.

d) Reference: NET Standard (Section 5.5.4.2, Section 5.5.6.2).

e) Test type: Basic

A.2.5.2.1 Test Case for Namespace Declarations

a) Test identifier: NamespaceDeclarations

b) Test purpose: Verify the conformance of the product with the required declaration of namespace abbreviations supporting the use of short IRIs. (Conditional on the product using the RDF/XML encoding of the NET content)

c) Test method: Inspect the product in order to determine that it contains namespace abbreviations for the namespaces of resources referenced by short IRIs in the RDF/XML encoding of the NET content.

d) Reference: NET Standard (Section 5.5.4.2, Section 5.5.6.2).

e) Test type: Basic

A.2.5.2.2 Test Case for Short IRIs

a) Test identifier: ShortIRIs

b) Test purpose: Verify the conformance of the product with the use of short IRIs in the RDF/XML encoding of the NET content. (Conditional on the product using the RDF/XML encoding of the NET content)

c) Test method: Inspect the product in order to determine that the RDF/XML encoding of the NET content uses short IRIs, with namespace abbreviations, as specified in the NET standard.

d) Reference: NET Standard (Section 5.5.4.2, Section 5.5.6.2).

e) Test type: Basic

A.2.5.2.3 Test Case for SKOS Type for RDF Subject

a) Test identifier: SKOSTypeForRDFSubject

b) Test purpose: Verify the conformance of the product with the typing of the node element representing the subject of the RDF triple based on the (declared or inherited) SKOS type of the source vocabulary term as either a SKOS Concept or a SKOS Concept Scheme. (Conditional on the product using the RDF/XML encoding of the NET content)

c) Test method: Inspect the product to determine that the subject of the RDF triple representing the term-match is either SKOS Concept (`skos:Concept`) or SKOS Concept Scheme (`skos:ConceptScheme`), and that the type is consistent with the representation of the vocabulary term in the vocabulary where it is defined.

d) Reference: NET Standard (Section 5.5.4.2 (Table 10 (row 4)); Section 5.5.6.2 (c), Figure 7); vocabulary term information referenced by IRI.

e) Test type: Basic

A.2.5.3 Test Module for N-Triples Technology-specific Encoding

a) Test identifier: NTriplesEncoding

b) Test purpose: Verify the conformance of the product with the technology-specific requirements of the N-Triples encoding of the NET content, as specified in the NET Standard and NET content. (Conditional on the product using the N-Triples encoding of the NET content)

c) Test method: Inspect the product in order to determine that it is conformant with the technology-specific requirements of the N-Triples encoding of the NET content.

d) Reference: NET Standard (Section 5.5.4.3, Section 5.5.6.3).

e) Test type: Basic

A.2.5.3.1 Test Case for Full IRIs

a) Test identifier: FullIRIs

b) Test purpose: Verify the conformance of the product with the use of full-length IRIs in the N-Triples encoding of the NET content. (Conditional on the product using the N-Triples encoding of the NET content)

c) Test method: Inspect the product in order to determine that the N-Triples encoding of the NET content uses full-length (*i.e.*, unabbreviated) IRIs.

d) Reference: NET Standard (Section 5.5.4.3, Section 5.5.6.3).

e) Test type: Basic

Annex B – ICS Pro Forma

(Normative)

B.1 Introduction

An Implementation Conformance Statement (ICS) is a statement made by the supplier of an implementation or system that is claimed to conform to a given standard (or a set of standards), in which it is declared which capabilities have been implemented in the product in conformance with the standard. This is especially important when there are options that may be implemented (or not), so that a tester may evaluate the conformance of an implementation against the relevant requirements. An ICS pro forma provides a uniform means for the implementer to declare the mandatory, conditional, and optional provisions of the standard that were implemented.

The Abstract Test Suite (ATS) for the NET Standard, Edition 1.0, is a compendium of abstract test cases that provide a basis for verifying the structure and content of vocabulary content encodings conformant with the NET Standard. Annex A defined one conformance class (Class A) for the NET. Annex B offers an ICS Pro Forma template for implementations claiming conformance with that class.

B.2 NET ICS Pro Forma

The ICS Pro Forma presented in Table 14 shall be used by the supplier or sponsor of an implementation as a framework to document the standards-conformant capabilities of the implementation of this standard in conformance with Class A.

The NET ICS Pro Forma shall provide the following information:

- The **Implementation Under Test (IUT)** provides the name of the realization of a specification that is the focus of the test.
- The **Test Sponsor** information includes the name, organization, and contact information for the individual or organization that is submitting the implementation for testing.
- The **Date of Initial ICS Completion** is the date on which the Test Sponsor submitted the completed Implementation Conformance Statement.
- The **Conformance Class (A)** designates the set of conformance requirements pertinent to the test. The IUT submitted with this Pro Forma shall conform to Class A requirements as specified by Annex A of this standard.
- The **NET Content Baseline** specifies the version number of the NET content to which the IUT claims conformance.
- The **Supported Encoding(s)** identifies which official NET content encoding(s) are used by the IUT, which shall be either the RDF/XML encoding or the N-Triples encoding, or both.
- The **Test Point(s)** information specifies where the test is to be applied (*e.g.*, at input or output from the implementation, or to static content).
- The **Test Organization** information includes the name of the organization, the POC, and contact information for the organization that is performing the conformance test.
- The **Date of Test Completion** is the date on which the Test Organization completed the conformance testing, including results returned to the Test Sponsor.

Table 14 – ICS Pro Forma for NET Content

NET (Class A) – Implementation Conformance Statement (ICS)

Column Key: B = Baseline NET S = Subset Obligation I = Implemented P/F = Pass/Fail

Column Values: M = Mandatory O = Optional C = Conditional

Implementation Under Test (IUT): **Conformance Class: A**
Date of Initial ICS Completion: **Test Point(s):**
NET Content Baseline (Version #): **Test Sponsor:**
Vocabularies Referenced (names & IRIs) (attach sheet for more): **Test Organization:**
1. **Date of Test Completion:**
2.
Supported Encodings (RDF/XML and/or N-Triples):

Characteristic	Parameter	Obligation			
		B	S	I	P/F
General Capabilities. The NSG Enterprise Thesaurus (NET) content is a collection of term-matches establishing semantic correlations between vocabulary terms in different SKOS-based controlled vocabularies that are used to characterize GEOINT shared in the NSG. The NET content is represented in RDF triples encoded in RDF/XML and/or N-Triples format. Those parameters shown on the right as 'implemented' provide an indication of the capabilities enabled by the uses of NET content in the implementation under test (IUT). These parameters are informational only; the concept of pass/fail is not applicable for this characteristic.	NET content is used by a terminology server to provide preferred terms, synonyms (optional), and definitions of NSG controlled vocabulary (terminology).	O			
	NET content is used by a search application to provide cross-referenced keywords and/or synonyms used to shape user queries and/or search data resources.	O			
	NET content is used to enhance the annotation of data resources (*e.g.*, instance data, analytic reports, message payloads, *etc*.).	O			
	NET content is used to index data resources.	O			
	NET content is used by services that locate tagged data resources from local or remote network locations.	O			
	NET content is used in user interfaces to specify labels and menu choices aligned with NSG controlled vocabulary (terminology).	O			
	NET content is used selectively to serve a specific mission, domain, or application.	O			
	Other (Describe):	O			
	Other (Describe):	O			
	Other (Describe):	O			

NET (Class A) – Implementation Conformance Statement (ICS)

Column Key: B = Baseline NET S = Subset Obligation I = Implemented P/F = Pass/Fail

Column Values: M = Mandatory O = Optional C = Conditional

Implementation Under Test (IUT):
Date of Initial ICS Completion:
NET Content Baseline (Version #):
Vocabularies Referenced (names & IRIs) (attach sheet for more):
1.
2.
Supported Encodings (RDF/XML and/or N-Triples):

Conformance Class: A
Test Point(s):
Test Sponsor:
Test Organization:
Date of Test Completion:

Characteristic	Parameter	Obligation			
		B	S	I	P/F
Conformance Class A. The Abstract Test Suite (ATS) for the NET Standard, Edition 1.0, Class A (Annex A), is a compendium of abstract test cases that provide a basis for verifying the implementation of the structure and encoding of the NET content in the IUT. The implementation shall satisfy Conformance Class A, conditional on the intended capabilities of the implementation. Conformance to Class A is covered by this ICS.	Conformance Class A. NET content utilized or produced by this implementation conforms to the complete NET content. An implementation shall satisfy all tests in the ATS (NET Standard, Annex A) to be conformant.	M			
	The NET content utilized is based on a single, officially published NET content resource (as identified in this ICS), and contains NET term-matches drawn from that resource only. Provide either: NET Content Baseline (Version Number): _____ NET REST API Retrieved Resource (Date of Last Change): _____	M			
	A specification of the Vocabulary Terms related by term-matches in the NET content baseline identified in the ICS is provided by reference or copy; Vocabulary Terms are retrievable using their IRIs or are provided separately.	M			
	Each Vocabulary Term referenced in the NET content baseline identified in the ICS is an instance of either `skos:Concept` or `skos:ConceptScheme`, whether by direct declaration or by inheritance.	M			
	Each Vocabulary Term shall have the minimum required attribution as specified in the NET Standard, Section 5.5.4.4.	M			
	The NET content includes only term-matches whose matchStatus value is 'valid' as specified in the NET register item information for the NET content resource identified in the ICS.	M			
	Other (Describe):				
	Other (Describe):				

Annex C – NET Register Logical Data Model and XML Encoding

(Informative)

C.1 Introduction

The NET content is managed in the NET Register (http://nsgreg.nga.mil/voc/registers.jsp?register=NET) of the NSG Standards Registry. This annex specifies the logical data model employed in the NET Register to structure the information in registered items, which includes both NET content and associated register metadata.

The model diagram is followed by a tabular presentation of the information elements used in the model. The model includes documentation properties to record information about the thesaurus, its constituent term-matches, and one or more alignment contexts. An alignment context is a collection of term-matches from two referenced vocabularies, optionally with additional scope constraints based on topics, which may be used to group term-matches within the thesaurus.

This annex also specifies the XML Schema used to exchange the information content of the NET Register and two mechanisms that may be used to access the content of NET Register items – via a web browser and using the REpresentational State Transfer (REST) API component of the NSG Standards Registry.

This annex concludes by specifying a mechanism to access simple RDF-based encodings of NET term-match triples using the REST API component of the NSG Standards Registry.

C.2 Logical Data Model

C.2.1 Overview

Figure 11 presents the complete logical data model for the NET Register as a UML class diagram. Annex F provides a brief primer sufficient to understand UML class diagrams as used in this standard. In Figure 11, all classes whose stereotype is not explicitly specified are understood to have the stereotype «type» applied.

Each element of the NET Register logical data model is defined in the tables below, using the following table format:

- The **Reference** column consists of a sequentially-assigned, non-normative identifier of the element (class or property) that is provided for cross-referencing purposes. It may vary from version-to-version of this document.
- The **UML Designation** column specifies the class name, class attribute name, or class role name of the information modeling concept. For clarity, role names are prefixed by the italicized phrase "*Role name*".
    - A specified class in the model has a capitalized name and always appears in the table on a grey-highlighted row above its properties.
    - The properties (attributes and/or association roles) of a model class are specified in subsequent rows of the table below the class row.
- The **Definition** column specifies the definition of the model class or property.
- The **Obligation** column specifies if the property is **Mandatory**, Conditional, or *Optional*.
    - Properties whose obligation is "**Mandatory**" shall be populated in accordance with the property definition and any associated guidance.
    - Properties whose obligation is "Conditional" are treated as mandatory when the stated condition is satisfied.
    - Properties whose obligation is *"Optional*" are optional, but their population is good business practice when the applicable information is available.
- The **Multiplicity** column indicates the number of instances of the value type of the property that are permitted by this information model. In the case that more than a single domain value of the property is allowed, an indication may also be included in this column if the ordering of the domain values is significant.

- The **Value Type** column indicates the modeling class or datatype that is used to define the value(s) of the property.

Annex C.2.2 specifies the UML class that is used to represent information regarding the thesaurus and its properties.

Annex C.2.3 specifies the UML class that is used to represent information regarding an alignment context and its properties.

Annex C.2.4 specifies the UML class that is used to represent information regarding a term-match and its properties, together with constraints applicable to the semantic matching relations.

Annex C.2.5 specifies the datatypes used in the NET Register logical data model.

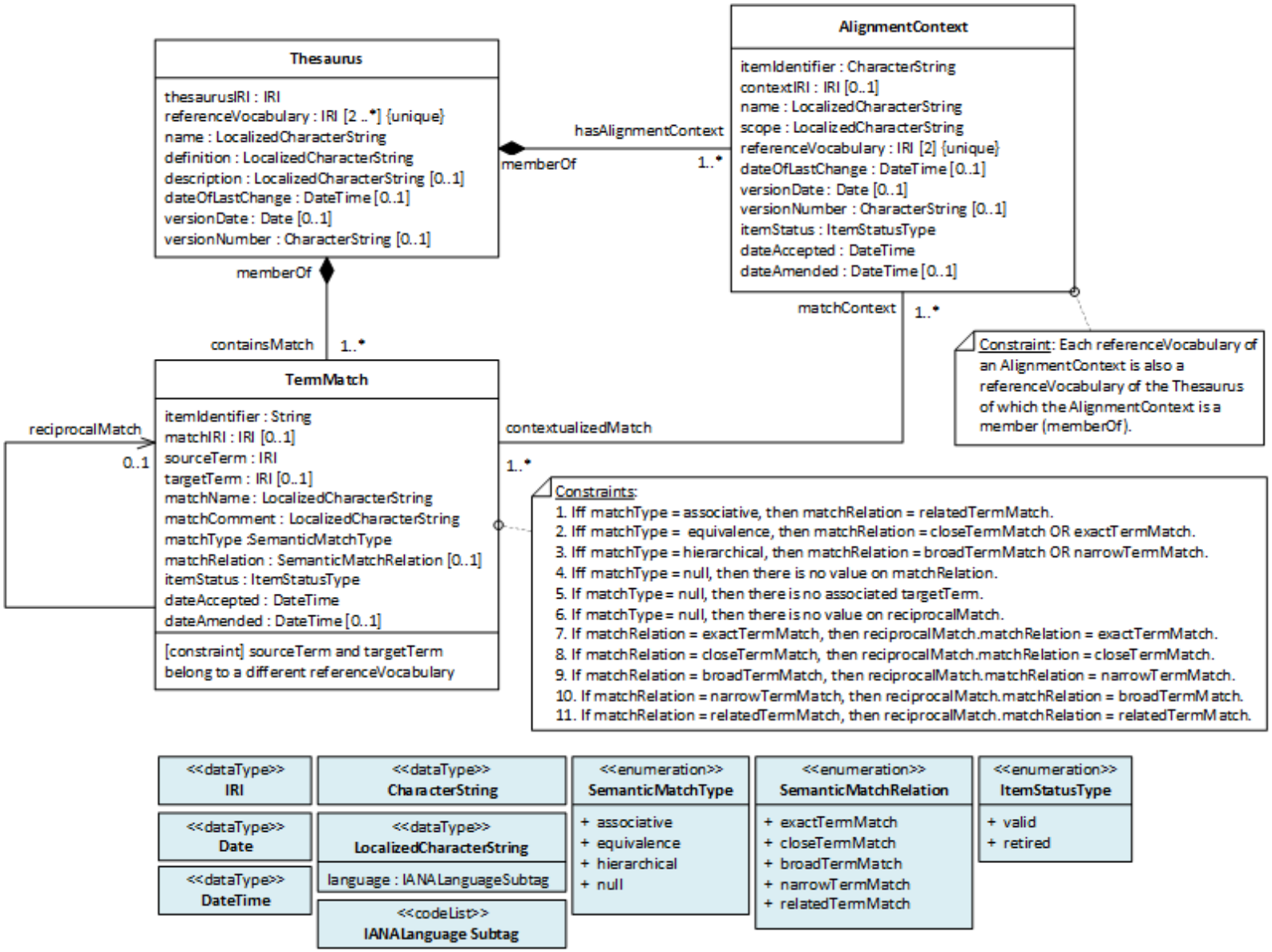

Figure 11 – The NET Register Logical Data Model

C.2.2 Class Thesaurus

The UML model for the <<type>> `Thesaurus` class and its properties is presented in Table 15 below. The class `Thesaurus` models a set of term-matches that may reference vocabulary terms from two or more specified vocabularies.

Table 15 – The <<type>> Thesaurus and its Properties

Reference	UML Designation	Definition	Obligation	Multiplicity	Value Type
1.	<<type>> Thesaurus	A structured vocabulary in which vocabulary terms from two or more vocabularies are organized by pairwise semantic relations which make explicit the relationship between the meanings of the vocabulary terms.			
2.	thesaurusIRI	An Internationalized Resource Identifier (IRI) that uniquely identifies a thesaurus as a resource.	**Mandatory**	Exactly one	<<dataType>> URI (ISO 19103)
3.	referenceVocabulary	A vocabulary containing one or more vocabulary terms associated to term-matches in this resource.	**Mandatory**	Two or more *{unique}*	<<dataType>> URI (ISO 19103)
4.	name	The preferred human-readable lexical item *(i.e.*, word, phrase, or abbreviation) that is used to designate a resource in a specified natural language.	**Mandatory**	Exactly one	<<dataType>> Localized CharacterString
5.	definition	A precise statement of the nature and content of the thesaurus.	**Mandatory**	Exactly one	<<dataType>> Localized CharacterString
6.	description	A statement or statements providing supplemental information about the thesaurus, including its background, content, scope, format, variations, and/or examples.	*Optional*	Zero or one	<<dataType>> Localized CharacterString
7.	dateOfLastChange	The date and time of the most recent change made to a managed resource.	Conditional	If applicable, then zero or one	<<dataType>> DateTime (ISO 19103)
8.	versionDate	The date associated with the official publication of a specific version of a managed resource.	Conditional	If applicable, then zero or one	<<dataType>> Date (ISO 19103)
9.	versionNumber	A structured character sequence that specifies a unique state in the life of a managed resource according to a specified versioning scheme.	Conditional	If applicable, then zero or one	<<dataType>> CharacterString (ISO 19103)
10.	*Role name:* hasAlignmentContext	A resource that collects term-matches between two referenced vocabularies, optionally with additional scope constraints.	**Mandatory**	One or more	<<type>> AlignmentContext (See Table 16)
11.	*Role name:* containsMatch	A term-match that belongs to this thesaurus.	**Mandatory**	One or more	<<type>> TermMatch (See Table 17)

C.2.3 Class AlignmentContext

The UML model for the <<type>> `AlignmentContext` class models and its properties is presented in Table 16 below. The class `AlignmentContext` models a collection of term-matches that reference vocabulary terms from exactly two specified vocabularies and which may be further restricted to vocabulary terms used in a specialized domain or topic (*e.g.*, aeronautical or aerodromes).

Table 16 – The <<type>> AlignmentContext and its Properties

Reference	UML Designation	Definition	Obligation	Multiplicity	Value Type
1.	<<type>> AlignmentContext	A collection of term-matches from two referenced vocabularies (optionally with additional scope constraints).			
2.	itemIdentifier	A string of characters designating a resource for purposes of unique identification within a specified context.	**Mandatory**	Exactly one	<<dataType>> CharacterString (ISO 19103)
3.	contextIRI	An Internationalized Resource Identifier (IRI) that uniquely identifies an alignment context as a resource.	*Optional*	Zero or one	<<dataType>> URI (ISO 19103)
4.	name	The preferred human-readable lexical item (i.e., word, phrase, or abbreviation) that is used to designate a resource in a specified natural language.	**Mandatory**	Exactly one	<<dataType>> Localized CharacterString
5.	scope	A description of the purpose and/or extent of the content included in this resource.	**Mandatory**	Exactly one	<<dataType>> Localized CharacterString
6.	referenceVocabulary	A vocabulary containing one or more vocabulary terms associated to term-matches in this resource.	**Mandatory**	Exactly two *{unique}*	<<dataType>> URI (ISO 19103)
7.	dateOfLastChange	The date and time of the most recent change made to a managed resource.	Conditional	If applicable, then zero or one	<<dataType>> DateTime (ISO 19103)
8.	versionDate	The date associated with the official publication of a specific version of a managed resource.	Conditional	If applicable, then zero or one	<<dataType>> Date (ISO 19103)
9.	versionNumber	A structured character sequence that specifies a unique state in the life of a managed resource according to a specified versioning scheme.	Conditional	If applicable, then zero or one	<<dataType>> CharacterString (ISO 19103)
10.	itemStatus	The standing of an item with respect to inclusion in a managed resource.	**Mandatory**	Exactly one	<<enumeration>> ItemStatusType
11.	dateAccepted	The date and (optionally) time on which an approved item was initially included in a managed resource.	**Mandatory**	Exactly one	<<dataType>> DateTime (ISO 19103)
12.	dateAmended	The date and (optionally) time on which an item was retired in a managed resource.	Conditional	If applicable, then zero or one	<<dataType>> DateTime (ISO 19103)
13.	*Role name:* memberOf	The thesaurus which contains all the term-matches collected by this alignment context.	**Mandatory**	Exactly one	<<type>> Thesaurus (See Table 15)

Reference	UML Designation	Definition	Obligation	Multiplicity	Value Type
14.	*Role name:* contextualizedMatch	A term-match that is collected by this alignment context.	**Mandatory**	One or more	<<type>> TermMatch (See Table 17)

C.2.4 Class TermMatch

The UML model for the <<type>> `TermMatch` class and its properties is presented in Table 17 below. The class `TermMatch` models information about the semantic relationship between the meanings of two vocabulary terms from two different vocabularies.

Table 17 – The <<type>> TermMatch and its Properties

Reference	UML Designation	Definition	Obligation	Multiplicity	Value Type
1.	<<type>> TermMatch	A dated, individual information record specifying the relationship between a vocabulary term from one vocabulary to a vocabulary term in a different vocabulary, based on the meanings of the two terms, and including references to the source term, target term (if applicable), type of relationship, and specific semantic relation (if the relationship is non-null).			
2.	itemIdentifier	A string of characters designating a resource for purposes of unique identification within a specified context.	**Mandatory**	Exactly one	<<dataType>> CharacterString (ISO 19103)
3.	matchIRI	An Internationalized Resource Identifier (IRI) that uniquely identifies a term-match as a resource.	*Optional*	Zero or one	<<dataType>> URI (ISO 19103)
4.	sourceTerm	The vocabulary term in the source vocabulary for which a term-match is assigned in a target vocabulary.	**Mandatory**	Exactly one	<<dataType>> URI (ISO 19103)
5.	targetTerm	The vocabulary term to which a term-match is assigned if a match exists in the target vocabulary.	Conditional	If applicable, then exactly one	<<dataType>> URI (ISO 19103)
6.	matchName	The preferred human-readable lexical item (i.e., word, phrase, or abbreviation) that is used to designate a term-match in a specified natural language.	**Mandatory**	Exactly one	<<dataType>> Localized CharacterString
7.	matchComment	A statement or statements providing information about a term-match, including background or context intended to help the user understand the basis or scope of the semantic relation established between the two vocabulary terms.	**Mandatory**	Exactly one	<<dataType>> Localized CharacterString
8.	matchType	The general characterization of a term-match that relates the meaning of the source term to the meaning of a vocabulary term in the target vocabulary (including possibly no match).	**Mandatory**	Exactly one	<<enumeration>> SemanticMatch Type (See Table 18)

Reference	UML Designation	Definition	Obligation	Multiplicity	Value Type
9.	matchRelation	The semantic relation assigned by this term-match to indicate the relationship of the meaning of the source term to the meaning of the target term.	Conditional	If applicable, then exactly one	<<enumeration>> SemanticMatch Relation (See C.2.5.2.2)
10.	itemStatus	The standing of an item with respect to inclusion in a managed resource.	**Mandatory**	Exactly one	<<enumeration>> ItemStatusType
11.	dateAccepted	The date and (optionally) time on which an approved item was initially included in a managed resource.	**Mandatory**	Exactly one	<<dataType>> DateTime (ISO 19103)
12.	dateAmended	The date and (optionally) time on which an item was retired in a managed resource.	Conditional	If applicable, then zero or one	<<dataType>> DateTime (ISO 19103)
13.	*Role name:* memberOf	The thesaurus of which this term-match is a part.	**Mandatory**	Exactly one	<<type>> Thesaurus (See Table 15)
14.	*Role name:* reciprocalMatch	A term-match specifying the semantic relation in the reverse direction (*i.e.*, from the target term to the source term) of the semantic relation in this term-match.	*Optional*	Zero or one	<<type>> TermMatch (See Table 17)
15.	*Role name:* matchContext	An alignment context by which this term-match is collected.	**Mandatory**	One or more	<<type>> AlignmentContext (See Table 16)

C.2.5 Datatypes

C.2.5.1 Basic Datatypes

The basic datatypes included in the NET register logical data model are represented as follows:

- The basic datatype `CharacterString` is as specified in ISO 19103:2015, *Geographic information – Conceptual schema language*.
- The basic datatype `DateTime` is as specified in ISO 19103:2015, *Geographic information – Conceptual schema language*.
- The basic datatype `IRI` is represented using the XML datatype `xsd:anyURI`.
- The basic datatype `LocalizedCharacterString` is represented using the RDF datatype `rdf:PlainLiteral` with the constraint that a language token is required that identifies the natural language used to interpret the content of the string. The language token is provided from the codelist IANALanguageSubtag.

C.2.5.2 Simple Datatypes

C.2.5.2.1 SemanticMatchType

The <<enumeration>> `SemanticMatchType` is specified in Table 18 below.

Table 18 – The <<enumeration>> SemanticMatchType and its Enumerants

Reference	UML Designation	Definition
1.	SemanticMatchType	A coded domain value describing the general characterization of a term-match which relates the source term to a vocabulary term in the target vocabulary, based on the meanings of the two terms (or possibly indicates there is no match).
2.	associative	The meaning of the source term is related to the meaning of a vocabulary term in the target vocabulary, but not by equivalence or by a hierarchical relation.
3.	equivalence	The meaning of the source term is the same or nearly the same as the meaning of a vocabulary term in the target vocabulary.
4.	hierarchical	The meaning of the source term is related asymmetrically to the meaning of a vocabulary term in the target vocabulary as either broader (generic) to narrower (specific), narrower (specific) to broader (generic).
5.	null	The source term is not related to any vocabulary term in the target vocabulary.

C.2.5.2.2 SemanticMatchRelation

The <<enumeration>> `SemanticMatchRelation` is as specified in Section 5.3.3.5.

C.2.5.2.3 ItemStatusType

The <<enumeration>> `ItemStatusType` is specified in Table 19 below. This enumeration is based on a subset of values from ISO 19135-1:2015, 7.5.2 (RE_ItemStatus).

Table 19 – The <<enumeration>> ItemStatusType and its Enumerants

Reference	UML Designation	Definition
1.	ItemStatusType	A coded domain value describing the standing of an item with respect to inclusion in a managed resource.
2.	valid	The item has been accepted, is recommended for use, and has not been retired.
3.	retired	The item is no longer recommended for use.

C.2.5.2.4 IANALanguageSubtag

The domain values of the <<codelist>> `IANALanguageSubtag` are represented using the two-character lowercase abbreviations for the names of languages (*e.g.*, “en” for English) as specified in RFC 5646 (BCP 47).

C.3 XML Encoding of NET Register Items

Information from the NET Register about NET term-matches and their metadata is published in an XML encoding. This encoding is determined by a XML Schema (XSD) whose namespace is:

http://api.nsgreg.nga.mil/schema/net/1.0

The current version of that schema is specified at:

http://api.nsgreg.nga.mil/schema/net/1.0.0/net.xsd

Figure 12 illustrates the structure of the XML encoding of the UML class `Thesaurus` as applied to NET register content in an NET content baseline; Figure 13 is an example XML encoding in accordance with that structure.

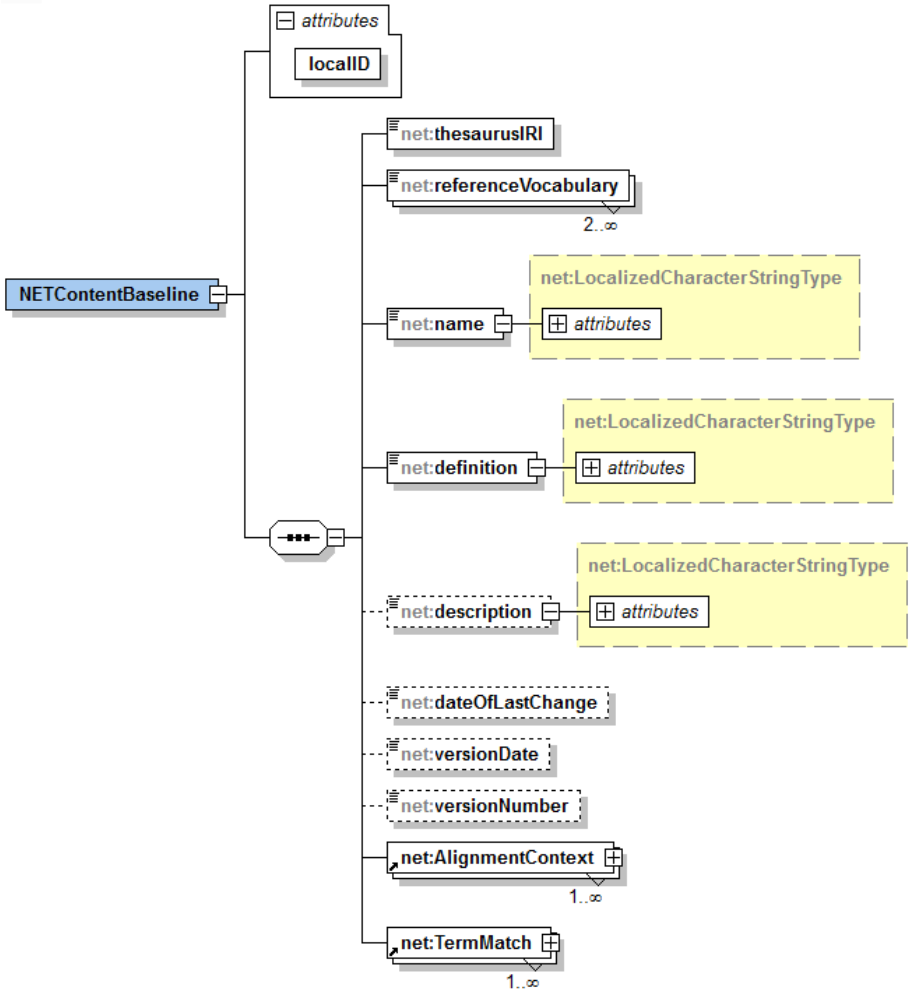

Figure 12 – XSD Structure for the UML class `Thesaurus`

```
<net:NETContentBaseline
    xmlns:net="http://api.nsgreg.nga.mil/schema/net/1.0"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xsi:schemaLocation="http://api.nsgreg.nga.mil/schema/net/1.0
                        http://api.nsgreg.nga.mil/schema/1.0.0/net.xsd"
    localID="NET">
 <net:thesaurusIRI>http://api.nsgreg.nga.mil/vocabulary/net</net:thesaurusIRI>
 <net:referenceVocabulary>http://api.nsgreg.nga.mil/vocabulary/inst-geo-service
     </net:referenceVocabulary>
 <net:referenceVocabulary>http://api.nsgreg.nga.mil/vocabulary/ncv
     </net:referenceVocabulary>
 <net:referenceVocabulary>http://api.nsgreg.nga.mil/vocabulary/codelist
     </net:referenceVocabulary>
 <net:name xml:lang="en">NSG Enterprise Thesaurus (NET)</net:name>
 <net:definition xml:lang="en">The NSG Enterprise Thesaurus ...</net:definition>
 <net:description xml:lang="en">A thesaurus is a …</net:description>
 <net:dateOfLastChange>2018-06-08T05:00:00Z</net:dateOfLastChange>
 <net:versionNumber>1-1</net:versionNumber>

 <net:AlignmentContext localID="IgvCdv">
    <net:itemIdentifier>2190002</net:itemIdentifier>
    <net:contextIRI>IgvCdv</net:contextIRI>
    …
    <net:contextualizedMatch>match_2100309</net:contextualizedMatch>
    <net:contextualizedMatch>match_2100310</net:contextualizedMatch>
    …
 </net:AlignmentContext>
 …
 <net:TermMatch localID="match_2100078">
    <net:itemIdentifier>2100078</net:itemIdentifier>
    <net:matchIRI>http://api.nsgreg.nga.mil/vocabulary/
                  net/AcousticStationNCVtoNoiseMonitoringLocationIGV</net:matchIRI>
    <net:sourceTerm>http://api.nsgreg.nga.mil/vocabulary/
                  ncv/AcousticStation</net:sourceTerm>
    <net:targetTerm>http://api.nsgreg.nga.mil/vocabulary/
                   inst-geo-service/NoiseMonitoringLocation</net:targetTerm>
    …
 </net:TermMatch>
 …
</net:NETContentBaseline>
```

Figure 13 – XML Encoding Example: net:NETContentBaseline

Figure 14 illustrates the structure of the XML encoding of the UML class `AlignmentContext`; Figure 15 is an example XML encoding in accordance with that structure.

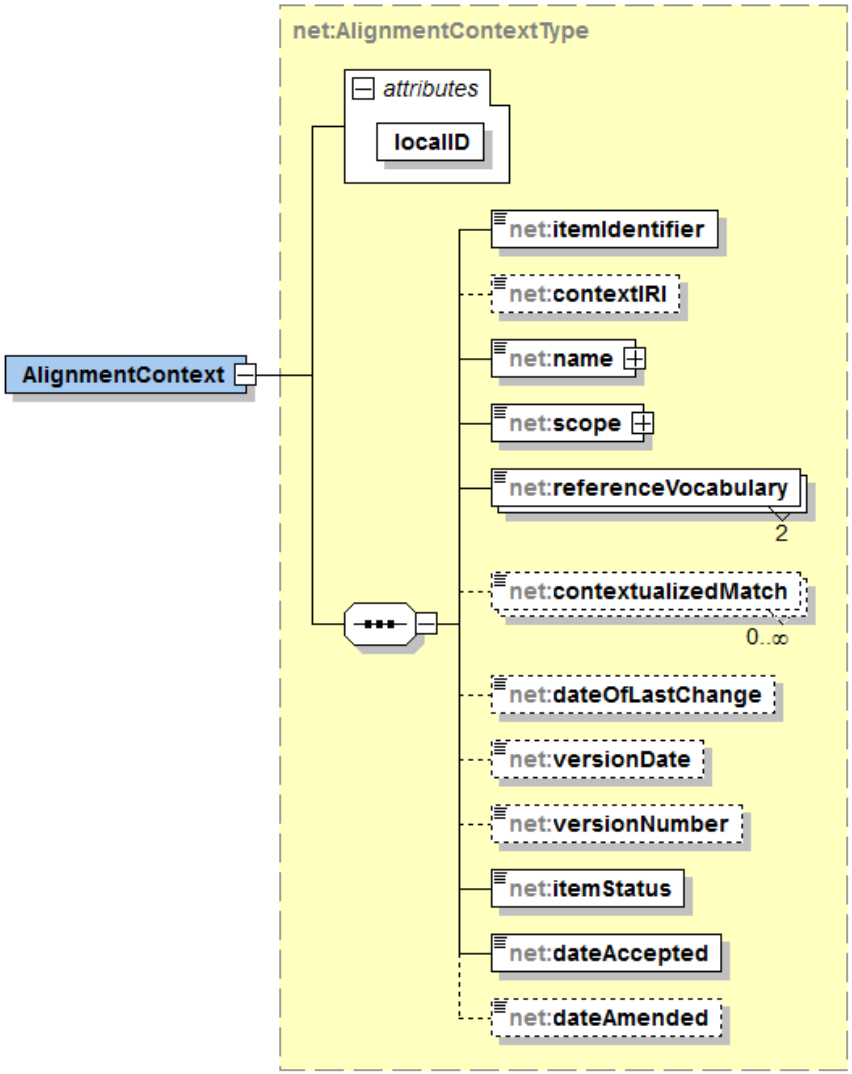

Figure 14 – XSD Structure for the UML class `AlignmentContext`

```
<net:AlignmentContext localID="IgvNcv">
    <net:itemIdentifier>2190001</net:itemIdentifier>
    <net:contextIRI>IgvNcv</net:contextIRI>
    <net:name xml:lang="en">DoD Installation Geospatial Vocabulary (IGV)
        and NSG Core Vocabulary (NCV)</net:name>
    <net:scope xml:lang="en">This thesaurus relates terms included in the DoD
        Installation Geospatial Vocabulary (IGV) to terms included in the NSG
        Core Vocabulary (NCV), where applicable.</net:scope>
    <net:referenceVocabulary>http://api.nsgreg.nga.mil/vocabulary/
        inst-geo-service</net:referenceVocabulary>
    <net:referenceVocabulary>http://api.nsgreg.nga.mil/vocabulary/
        ncv</net:referenceVocabulary>
    <net:contextualizedMatch>match_2100002</net:contextualizedMatch>
    <net:contextualizedMatch>match_2100003</net:contextualizedMatch>
    <net:contextualizedMatch>match_2100004</net:contextualizedMatch>
    <net:contextualizedMatch>match_2100005</net:contextualizedMatch>
    <net:contextualizedMatch>match_2100006</net:contextualizedMatch>
    <net:contextualizedMatch>match_2100007</net:contextualizedMatch>
    <net:contextualizedMatch>match_2100008</net:contextualizedMatch>
    <net:contextualizedMatch>match_2100009</net:contextualizedMatch>
    <net:contextualizedMatch>match_2100010</net:contextualizedMatch>
    <net:contextualizedMatch>match_2100011</net:contextualizedMatch>
    …
    <net:contextualizedMatch>match_2100310</net:contextualizedMatch>
    <net:dateOfLastChange>2018-06-30T05:00:00Z</net:dateOfLastChange>
    <net:versionDate>2018-07-13</net:versionDate>
    <net:versionNumber>1-1</net:versionNumber>
    <net:itemStatus>valid</net:itemStatus>
    <net:dateAccepted>2018-02-26T05:00:00Z</net:dateAccepted>
</net:AlignmentContext>
```

Figure 15 – XML Encoding Example: net:AlignmentContext

Note that the XML Schema built-in datatypes ID and IDREF are used to link each alignment context to its associated term-matches.

Figure 16 illustrates the structure of the XML encoding of the UML class `TermMatch`; Figure 17 is an example XML encoding in accordance with that structure.

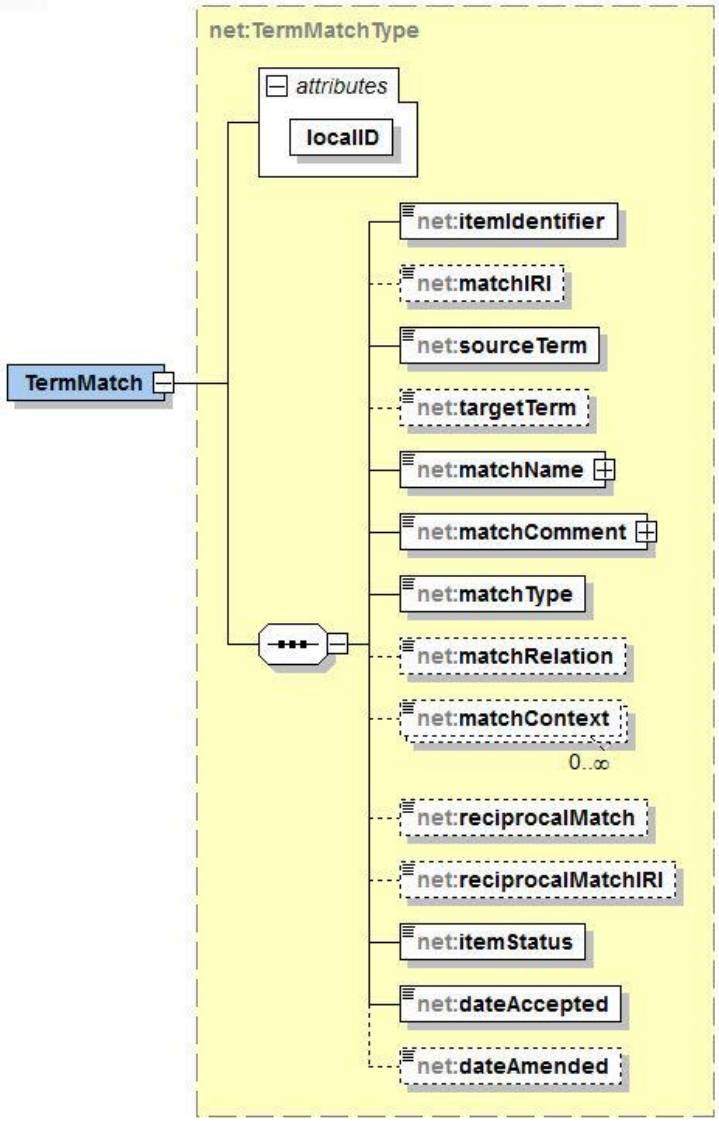

Figure 16 – XSD Structure for the UML class `TermMatch`

```
<net:TermMatch localID="match_2100078">
   <net:itemIdentifier>2100078</net:itemIdentifier>
   <net:matchIRI>http://api.nsgreg.nga.mil/vocabulary/
         net/AcousticStationNCVtoNoiseMonitoringLocationIGV</net:matchIRI>
   <net:sourceTerm>http://api.nsgreg.nga.mil/vocabulary/
         ncv/AcousticStation</net:sourceTerm>
   <net:targetTerm>http://api.nsgreg.nga.mil/vocabulary/inst-geo-
service/NoiseMonitoringLocation</net:targetTerm>
   <net:matchName xml:lang="en">Acoustic Station (NCV) to Noise Monitoring
         Location (IGV)</net:matchName>
   <net:matchComment xml:lang="en">Variations between the definitions of the two
terms are not considered to be significant.</net:matchComment>
   <net:matchType>equivalence</net:matchType>
   <net:matchRelation>exactTermMatch</net:matchRelation>
   <net:matchContext>IgvNcv</net:matchContext>
   <net:reciprocalMatch>match_2100027</net:reciprocalMatch>
   <net:itemStatus>valid</net:itemStatus>
   <net:dateAccepted>2018-02-26T05:00:00Z</net:dateAccepted>
</net:TermMatch>

<net:TermMatch localID="match_2100027">
   <net:itemIdentifier>2100027</net:itemIdentifier>
   <net:matchIRI>http://api.nsgreg.nga.mil/vocabulary/
         net/NoiseMonitoringLocationIGVtoAcousticStationNCV</net:matchIRI>
   <net:sourceTerm>http://api.nsgreg.nga.mil/vocabulary/
         inst-geo-service/NoiseMonitoringLocation</net:sourceTerm>
   <net:targetTerm>http://api.nsgreg.nga.mil/vocabulary/
         ncv/AcousticStation</net:targetTerm>
   <net:matchName xml:lang="en">Noise Monitoring Location (IGV) to Acoustic Station
(NCV)</net:matchName>
   <net:matchComment xml:lang="en">Variations between the definitions of the two
terms are not considered to be significant.</net:matchComment>
   <net:matchType>equivalence</net:matchType>
   <net:matchRelation>exactTermMatch</net:matchRelation>
   <net:matchContext>IgvNcv</net:matchContext>
   <net:reciprocalMatch>match_2100078</net:reciprocalMatch>
   <net:itemStatus>valid</net:itemStatus>
   <net:dateAccepted>2018-02-26T05:00:00Z</net:dateAccepted>
</net:TermMatch>
```

Figure 17 – XML Encoding Example: net:TermMatch

Note the XML Schema built-in datatypes ID and IDREF are used to link each term-match to its associated alignment context(s) as well as to its reciprocal match, if any.

C.4 Accessing NET Register Items via a Web Browser

Information in the NET Register about NET alignment contexts and term-matches may be accessed (including browsing, searching, and item inspection) through a web browser. The NET Register is accessible at:

http://nsgreg.nga.mil/voc/registers.jsp?register=NET

An example browser presentation of a registered item of the <<type>> `AlignmentContext` class (see Section C.2.3) is illustrated in Figure 18.

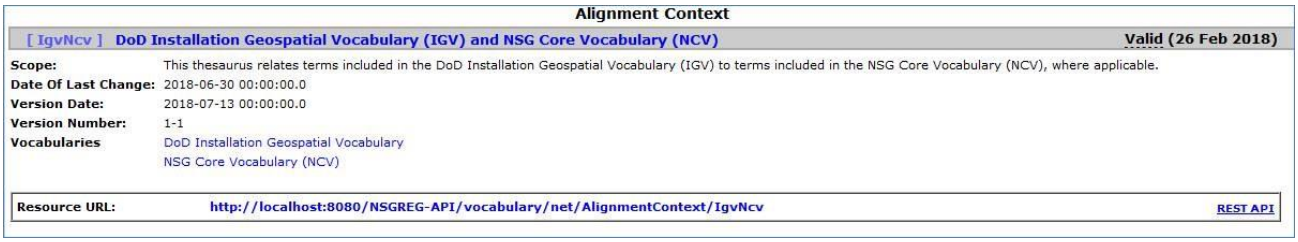

Figure 18 – Example Presentation of an `AlignmentContext` in the NET Register

An example browser presentation of a registered item of the <<type>> `TermMatch` class (see Section C.2.4) is illustrated in Figure 19.

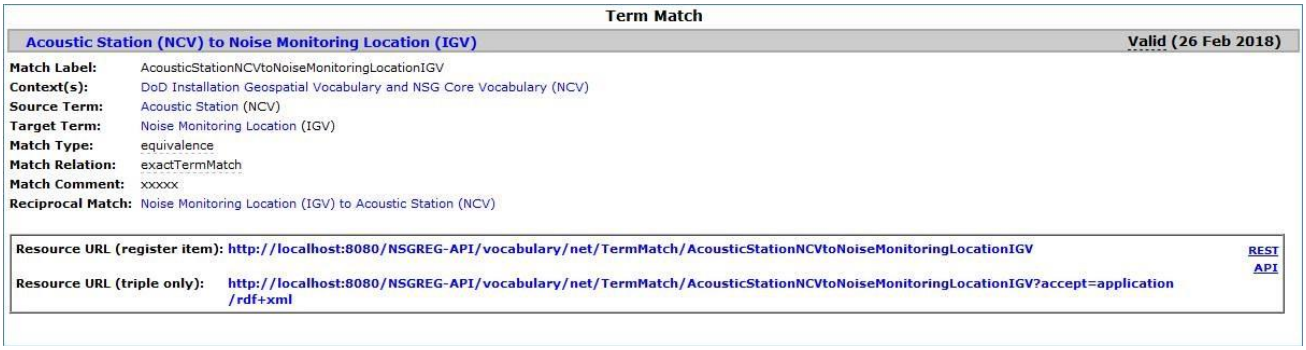

Figure 19 – Example Presentation of a `TermMatch` in the NET Register

C.5 Accessing XML Encodings of NET Register Items via a REST API

C.5.1 Overview

Information in the NET Register about NET alignment contexts and term-matches may be accessed through the REpresentational State Transfer (REST) API component of the NSG Standards Registry. This information may be retrieved for the complete content of the NET Register, content subsets based on the type of the registered item, or for individual registered items.

The NSG Standards Registry REST API supports content negotiation and in the absence of a client-specified media type will respond using a default media type that depends on the type of resource specified.

C.5.2 NET Register Content

The XML encoding for the complete NET Register content may be accessed at:

- http://api.nsgreg.nga.mil/vocabulary/net?accept=application/xml

In addition, RDF-based encodings (see Section 5.5) of currently valid NET content may be accessed at:

- http://api.nsgreg.nga.mil/vocabulary/net?accept=application/rdf+xml
- http://api.nsgreg.nga.mil/vocabulary/net?accept=application/n-triples

In the absence of a client-specified media type the default media type ‘application/rdf+xml’ will be used for requests for complete NET content, *i.e.*:

- http://api.nsgreg.nga.mil/vocabulaty/net

C.5.3 NET Register Content Subsets

The XML encoding for the alignment context subset of the NET Register content may be accessed at:

- http://api.nsgreg.nga.mil/vocabulary/net/AlignmentContext?accept=text/xml

The XML encoding for the term-match subset of the NET Register content may be accessed at:

- http://api.nsgreg.nga.mil/vocabulary/net/TermMatch?accept=text/xml

In both of these cases, in the absence of a client-specified media type the default media type 'text/xml' will be used for requests for complete NET content subsets, *i.e.*, respectively:

- http://api.nsgreg.nga.mil/vocabulary/net/AlignmentContext
- http://api.nsgreg.nga.mil/vocabulary/net/TermMatch

Note: There are no subsets of the RDF-based encodings of NET content.

C.5.4 NET Register Item Content

The XML encoding for an individual alignment context item in the NET Register may be accessed as, *e.g.*:

- http://api.nsgreg.nga.mil/vocabulary/net/AlignmentContext/IgvNcv?accept=text/xml

The XML encoding for an individual term-match item in the NET Register may be accessed as, *e.g.*:

- http://api.nsgreg.nga.mil/vocabulary/net/TermMatch/ZipCodeIGVtoPostalCodeNCV?accept=text/xml

In both of these cases, in the absence of a client-specified media type, the default media type 'text/xml' will be used for requests for individual items, *i.e.*, respectively:

- http://api.nsgreg.nga.mil/vocabulary/net/AlignmentContext/IgvNcv
- http://api.nsgreg.nga.mil/vocabulary/net/TermMatch/ZipCodeIGVtoPostalCodeNCV

C.6 Accessing RDF-based Encodings of NET Term-matches via a REST API

Simple RDF-based encodings of term-match triples may be accessed as, *e.g.*:

- http://api.nsgreg.nga.mil/vocabulary/net/TermMatch/ZipCodeIGVtoPostalCodeNCV?accept=application/rdf+xml
- http://api.nsgreg.nga.mil/vocabulary/net/TermMatch/ZipCodeIGVtoPostalCodeNCV?accept=application/n-triples

Figure 20 illustrates the simple RDF/XML encoding of a term-match.

```
<rdf:RDF
    xml:base="http://api.nsgreg.nga.mil/vocabulary/net"
    xmlns="http://api.nsgreg.nga.mil/vocabulary/net/"
    xmlns:net="http://api.nsgreg.nga.mil/vocabulary/net/"
    xmlns:netx="http://api.nsgreg.nga.mil/ontology/netx/1.0/"
    xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
    xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
    xmlns:skos="http://www.w3.org/2004/02/skos/core#" >
    <skos:Concept rdf:about="http://api.nsgreg.nga.mil/vocabulary/inst-geo-
service/zipCode">
        <skos:narrowMatch
rdf:resource="http://api.nsgreg.nga.mil/vocabulary/ncv/postalCode"/>
    </skos:Concept>
</rdf:RDF>
```

Figure 20 – Simple RDF/XML Encoding of a Term-match

Figure 21 illustrates the simple N-Triples encoding of a term-match.

```
<http://api.nsgreg.nga.mil/vocabulary/inst-geo-service/zipCode>
<http://www.w3.org/2004/02/skos/core#narrowMatch>
<http://api.nsgreg.nga.mil/vocabulary/ncv/postalCode> .
```

Figure 21 – Simple N-Triples Encoding of a Term-match

Annex D – NETX Utility Ontology for the NSG Enterprise Thesarus

(Normative)

D.1 Introduction

The NET Auxiliary Ontology (NETX) defines supplemental concepts used in the representation of NET content that are not available in SKOS. This includes semantic mapping properties needed for specifying the encodings of term-matches when one or both vocabulary terms are represented using SKOS Concept Scheme. These additional mapping properties are needed due to the domain and range limitations on SKOS semantic relations, which may be used only with terms encoded by SKOS Concept.[25] NEV component vocabularies contain types of vocabulary terms (*i.e.*, ComplexVocabularyTerm) that are encoded using SKOS Concept Scheme, as specified in the NCV Standard, Ed. 2.0.

This annex describes the elements of the NETX ontology.

The NETX is an OWL ontology and may be viewed in ontology tools that load OWL encoded in the mandatory RDF/XML syntax. Protégé is a widely used, free, open-source ontology editor that may be used for this purpose.[26]

D.2 Ontology IRIs for NETX

The NETX ontology corresponds to the content of the 'netx' namespace. IRIs for official content baselines of the NETX ontology are versioned. For convenience, use of the non-versioned IRI identifies the latest version.

A. IRI for NETX (versioned): http://api.nsgreg.nga.mil/ontology/netx/1.0

B. IRI for NETX (non-versioned): http://api.nsgreg.nga.mil/ontology/netx

The NETX ontology encoding (in RDF/XML) is available through the REST API component of the NSG Standards Registry using the IRIs specified above.

D.3 NETX Concepts

Concepts defined in the NETX ontology are presented in Table 20, below.

The table format used to document these encoding elements is as follows:

- The **Reference** column consists of a sequentially-assigned, non-normative identifier of the NETX ontology concept (class or property), which is provided for cross-referencing purposes. It may vary from version-to-version of this document.
- The **Concept Designation** column specifies the name of the NETX class or property.
- The **OWL Construct** column specifies the OWL 2 concept that is used to represent the corresponding NETX ontology concept.
- The **Concept Definition** column specifies the English-language definition of the ontology concept.
- The **Value Type** column specifies the value type for a NETX property.
- The **Source/Notes** column optionally contains a source reference for the NETX ontology concept and/or a comment about the concept.

IRIs for the ontology elements are formed by concatenating the versioned ontology IRI specified in Section D.2 with the "/" delimiter, followed by the Concept Designation listed in the table (for example: http://api.nsgreg.nga.mil/ontology/netx/1.0/exactTermMatch).

[25] SKOS Reference (Section 8.3): http://www.w3.org/TR/skos-reference/#L2055.
[26] Protégé may be downloaded online from http://protege.stanford.edu/.

Table 20 – Concepts in the NETX Ontology

Reference	Concept Designation	OWL Construct	Concept Definition	Value Type	Source / Notes
1.	termMatchRelation	Object Property	Definition: A generic semantic relation that is a collector for the specific semantic relations used to relate pairs of terms from two different vocabularies based on the meanings of the terms. Description: Each termMatchRelation is directional, from a vocabulary term in a source vocabulary (source term) to a vocabulary term in a target vocabulary (target term). Some termMatchRelations are symmetric (for example: exactTermMatch) while others are asymmetric (for example: broadTermMatch).	VocabularyTerm (defined as the disjointUnion of `skos:Concept` and `skos:ConceptScheme`)	
2.	exactTermMatch	Object Property	Definition: The source vocabulary term and target vocabulary term are equivalent in meaning. Description: exactTermMatch is a sub-property of closeTermMatch and disjoint with broadTermMatch, narrowTermMatch, and relatedTermMatch.	VocabularyTerm (defined as the disjointUnion of `skos:Concept` and `skos:ConceptScheme`)	The exactTermMatch relation is symmetric: If term A is an exact match with term B, then term B is an exact match with term A. The exactTermMatch relation is transitive: If a term A is an exact match with term B, and term B is an exact match with term C, then term A is an exact match with term C.
3.	closeTermMatch	Object Property	Definition: The source vocabulary term and target vocabulary term are sufficiently similar in meaning that they can be used interchangeably in specified contexts. Description: The close-match property is symmetric: If term A is a close match with term B, then term B is an exact match with term A. However, the close-match relation is not transitive, because the correlated vocabulary terms might not be equivalent in every context; therefore, the relation cannot be propagated across different pairs of close matches in which a term A is referenced.	VocabularyTerm (defined as the disjointUnion of `skos:Concept` and `skos:ConceptScheme`)	
4.	broadTermMatch	Object Property	Definition: The source vocabulary term has a more specialized meaning than the target vocabulary term. Description: The general meaning of the target vocabulary term is more inclusive than the meaning of the source vocabulary term, while also being essential to the meaning of the specialized source term. For example, color is a broader term than primary color.	VocabularyTerm (defined as the disjointUnion of `skos:Concept` and `skos:ConceptScheme`)	The relation broadTermMatch is the inverse of the relation narrowTermMatch. The relation broadTermMatch is not transitive (see broadTermMatchTransitive).

Reference	Concept Designation	OWL Construct	Concept Definition	Value Type	Source / Notes
5.	narrowTermMatch	Object Property	Definition: The source vocabulary term has a more general meaning than the target vocabulary term. Description: The more specialized vocabulary term has a meaning that is covered by the scope of the meaning of the general vocabulary term.	VocabularyTerm (defined as the disjointUnion of `skos:Concept` and `skos:ConceptScheme`)	The relation narrowTermMatch is the inverse of the relation broadTermMatch. The relationnarrowTermMatch is not transitive (see narrowTermMatchTransitive).
6.	relatedTermMatch	Object Property	Definition: The source vocabulary term and target vocabulary term have meanings that are relevant to each other in some way that is neither equivalent, similar, nor more general or specific. Description: The related-match relation is disjoint with the other termMatchRelations.	VocabularyTerm (defined as the disjointUnion of `skos:Concept` and `skos:ConceptScheme`)	The relation relatedTermMatch may be considered symmetric at the most general level of application: If term A is a related term to term B, then term B is a related term to term A. However, specializations of relatedTermMatch need not be symmetric.
7.	broadTermMatchTransitive	Object Property	Definition: The source vocabulary term has a more specialized meaning than the target vocabulary term and its broader term-matches.	VocabularyTerm (defined as the disjointUnion of `skos:Concept` and `skos:ConceptScheme`)	Similar to the use of skos:brroaderTransitive, the relation broadTermMatchTransitive is not used to make assertions, but instead used only to draw inferences. [SKOS Reference (8.6.6)]
8.	narrowTermMatchTransitive	Object Property	The source vocabulary term has a more general meaning than the target vocabulary term and its narrower term-matches.	VocabularyTerm (defined as the disjointUnion of `skos:Concept` and `skos:ConceptScheme`)	Similar to the use of skos:narrowerTransitive, the relation narrowTermMatchTransitive is not used to make assertions, but instead used only to draw inferences. [SKOS Reference (8.6.6)]

D.4 Publication of NETX

The NETX ontology is published (http://nsgreg.nga.mil/doc/view?i=4630) in the NSG Reference Documents Register within the Document Registry of the NSG Standards Registry.

The NETX ontology is also available through the REST API component of the NSG Standards Registry using either the versioned or non-versioned IRIs specified in Section D.2. The ontology is versioned for official use. The non-versioned URL returns the latest version.

Annex E – The NET Workbook

(Informative)

E.1 Introduction

The NET content is managed in the online NET Register of the NSG Standards Registry, as described in Section 6.2.2. The primary purpose of the normative technical artifacts containing NET content encodings is to provide machine-processable semantic information for use by applications. A selection of NET Register content for each content baseline is presented in an informative workbook for human consumption.

The NET Workbook is an Excel workbook that is an informative resource created solely for user convenience. The workbook contains three worksheets with the following tabs:

1. Cover
2. Alignment_Context
3. Term_Match.

The Cover worksheet explains the format of the workbook and its content worksheets that specify a subset of information from valid items in the NET Register as of the date the NET Workbook was created. The Alignment_Context worksheet presents a list of the alignment context(s) associated with term-matches published in the workbook. The Term_Match worksheet presents a subset of the contents of the specified NET content baseline in spreadsheet format. For complete information regarding included items, hyperlinks are provided to the complete specification of each specific item in the online NET Register.

E.2 Presentation of Alignment Contexts in the NET Workbook

The Alignment_Context tab contains a list of the alignment context(s) associated with term-matches published in the NET workbook, with the following information about each one:

- The **Label** column presents a human-readable but compressed (*i.e.*, no white spaces) unique identifier for the alignment context within the thesaurus. This identifier is hyperlinked to the presentation of the alignment context in the online NET Register, which has the complete specification of that alignment context.
- The **Name** column presents the preferred human-readable phrase that is used to designate the alignment context in the specified natural language.
- The **Scope** column presents a description of the purpose and/or extent of the content included in the alignment context.
- Two **Reference Vocabulary** columns each present the name of a different vocabulary containing one or more vocabulary terms associated to term-matches in the alignment context. The vocabulary name is linked to the online content of the vocabulary, where available.
- The **Date of Last Change** column presents the date and time of the most recent change made to the alignment context.
- The **Version Date** column presents the date associated with the official publication of a specific version of the alignment context.
- The **Version Number** column presents a structured character sequence that specifies a unique state in the life of the alignment context, according to a specified versioning scheme.
- The **Status** column presents the status of the alignment context as one of: Valid or Retired.

An alignment context is associated with term-matches that correlate vocabulary terms from the reference vocabularies of the alignment context. The alignment context includes term-matches made in both directions, that is, in which vocabulary terms from one reference vocabulary may be either source terms or target terms.

E.3 Presentation of Term-matches in the NET Workbook

The Term_Match tab contains a list of the term-matches published in the NET workbook, with the following information about each one (*Heading*:*Subheading* are indicated for each column):

- The Term Match: Source Vocabulary column presents the controlled vocabulary serving as the starting point for establishing pairs of term equivalents or other semantic relationships between vocabulary terms in different vocabularies.
- The Term Match: Target Vocabulary column presents the controlled vocabulary providing a term equivalent or other type of semantic match for a vocabulary term existing in a source vocabulary.
- The Term Match: Label column presents a human-readable but compressed (*i.e.*, no white spaces) unique identifier for the alignment context within the thesaurus. This identifier is linked to the presentation of the alignment context in the NET Register.
- The Term Match: Name column presents the preferred human-readable phrase that is used to designate the alignment context in the specified natural language.
- The Term Match: Comment column presents a statement or statements providing information about the Term Match, including background or context intended to help the user understand the basis or scope of the semantic relation established between the two vocabulary terms.
- The Term Match: Match Type column presents one of a set of domain values that either characterizes the general way in which the Term Match relates a source term to a vocabulary term in the target vocabulary (based on the meanings of the two terms) or indicates that there is no match.
- The Term Match: Match Relation column presents the semantic relation assigned by the Term Match to indicate the relationship of the meaning of the source term to the meaning of the target term.
- The Term Match: Match Status column presents the status of the alignment context as one of: Valid or Retired.
- The Term Match: Reciprocal Match column presents the name and link to the Term Match specifying the semantic relation in the reverse direction (*i.e.*, from the target term to the source term) of the semantic relation in the Term Match on the selected row.
- The Source Term: skos:prefLabel column presents the preferred human-readable word, phrase, or abbreviation that is used to designate the meaning of a vocabulary term in a specified language.
- The Source Term: SKOS Type column presents the type of SKOS representation of a vocabulary term, either "C" for Concept, or "CS" for Concept Scheme.
- The Source Term: skos:definition column presents a precise statement of the meaning of the source vocabulary term in a specified natural language.
- The Target Term: skos:prefLabel column presents the preferred human-readable word, phrase, or abbreviation that is used to designate the meaning of a vocabulary term in a specified language.
- The Target Term: SKOS Type column presents the type of SKOS representation of a vocabulary term, either "C" for Concept, or "CS" for Concept Scheme.
- The Target Term: skos:definition column presents a precise statement of the meaning of the target vocabulary term in a specified language.
- The Alignment Contexts: IGV <-> NCV column presents an indication that this Term Match is a member of the collection of term-matches between vocabulary terms in the DoD Installation Geospatial Vocabulary (IGV) and NSG Core Vocabulary (NCV).
- The Alignment Contexts: IGV <-> CDV column presents an indication that this Term Match is a member of the collection of term-matches between vocabulary terms in the DoD Installation Geospatial Vocabulary (IGV) and NSG Codelists Vocabulary (CDV).

E.4 Viewing Items in the NET Workbook

The NET Workbook is searchable by using Excel filters (in Data tools on the Ribbon) on one or more columns of the content worksheets. For example, NET content may be filtered on the column with header “Source” (in row 2) to view term-matches originating only from a single vocabulary (Column A on the Term_Match worksheet). For example, the Term_Match worksheet may be filtered to show the matches for which the Source is a term in the prototype IGV vocabulary.

Note: Users should ensure that left-arrow/right-arrow control icons are available in their command bars. If the workbook opens without left-arrow/right-arrow control icons in the command bars, use the right-mouse menu while selecting an empty command bar area to the right, select "Customize Quick Access Toolbar", and then add the "Back" and "Forward" commands (both being fat arrows inside a green-filled circle). Some cells in the workbook contain pre-computed hyperlinks. Re-sorting tabs/worksheets will result in anomalous cross-tab linking behavior and is therefore advised against.

Annex F – UML Primer

(Informative)

F.1 UML Notations

The diagrams that appear in this document are presented using the Unified Modeling Language (UML) static structure diagram with the ISO Interface Definition Language basic type definitions and the UML Object Constraint Language (OCL) as the conceptual schema language. The UML notations used in this Standard are described in Figure 22.

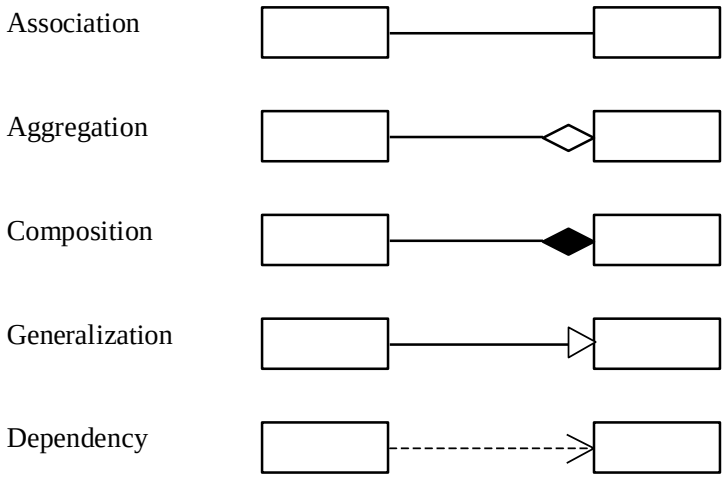

Figure 22 – UML Notation

F.2 UML Model Relationships

F.2.1 Associations

An association is used to describe a relationship between two or more classes. UML defines three different types of relationships, called association, aggregation and composition. The three types have different semantics. An ordinary association shall be used to represent a general relationship between two classes. The aggregation and composition associations shall be used to create part-whole relationships between two classes.

An aggregation association is a relationship between two classes in which one of the classes plays the role of container and the other plays the role of a containee.

A composition association is a strong aggregation. In a composition association, if a container object is deleted, then all of its containee objects are deleted as well. The composition association shall be used when the objects representing the parts of a container object cannot exist without the container object.

F.2.2 Navigation

Associations may be navigable in only one direction. If the direction is not specified, it is assumed to be a two-way association. If one-way associations are intended, the direction of the association can be marked by an arrow at the end of the line. Navigability means that instances participating in links at runtime (instances of an association) can be accessed efficiently from instances participating in links at the other end of the association. The precise mechanism by which such access is achieved is implementation specific. If an end is not navigable, access from the other ends may or may not be possible, and if it is, it might not be efficient.

F.2.3 Generalization

A generalization is a relationship between a superclass and the subclasses that may be substituted for it. The superclass is the generalized class, while the subclasses are specified classes.

F.2.4 Instantiation / Dependency

A dependency relationship shows that the client class depends on the supplier class/interface to provide certain services, such as:

- Client class accesses a value (constant or variable) defined in the supplier class/interface;
- Operations of the client class invoke operations of the supplier class/interface;
- Operations of the client class have signatures whose return class or arguments are instances of the supplier class/interface.

An instantiated relationship represents the act of substituting actual values for the parameters of a parameterized class or parameterized class utility to create a specialized version of the more general item.

F.2.5 Roles

If an association is navigable in a particular direction, the model shall supply a “role name” that is appropriate for the role of the target object in relation to the source object. Thus, in a two-way association, two role names will be supplied. Figure 23 represents how role names and cardinalities are expressed in UML diagrams.

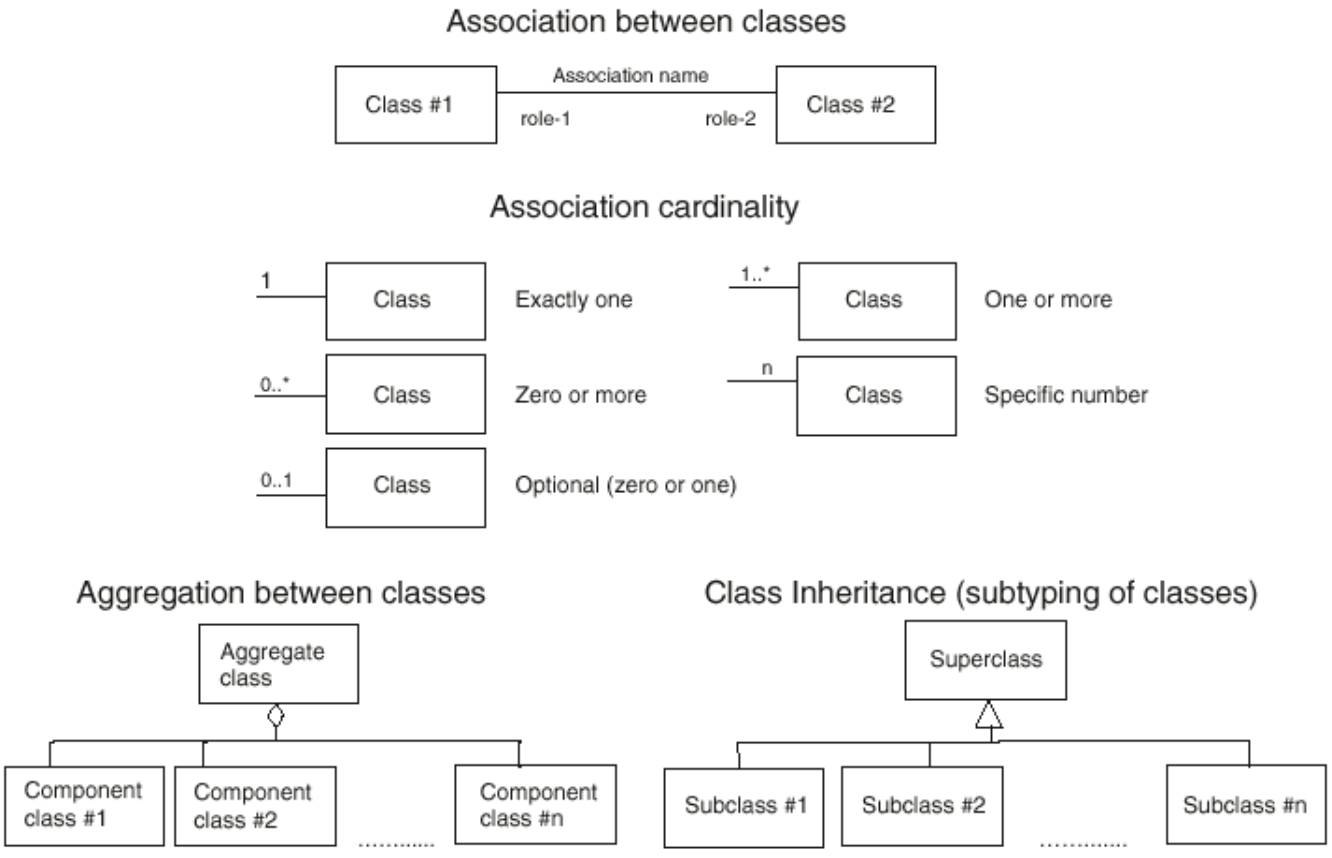

Figure 23 – UML Roles

F.3 UML Model Stereotypes

A UML stereotype is an extension mechanism for existing UML concepts. It is a model element that is used to classify (or mark) other UML elements so that they in some respect behave as if they were instances of new virtual or pseudo metamodel classes whose form is based on existing base metamodel classes. Stereotypes augment the classification mechanisms on the basis of the built-in UML metamodel class hierarchy. Below are brief descriptions of the stereotypes used in this document.

a. <<enumeration>> datatype whose instances form a list of named literal values. Both the enumeration name and its literal values are declared. Enumeration means a short list of well-understood potential values within a class.

b. <<dataType>> a descriptor of a set of values that lack identity and whose operations do not have side effects. Datatypes include primitive pre-defined types and user-definable types. Pre-defined types include numbers, string, and time. User-definable types include enumerations.

c. <<codeList>> used to describe a more open enumeration. <<codeList>> is a flexible enumeration. Code lists are useful for expressing a long list of potential values. If the elements of the list are completely known, an enumeration should be used; if the only likely values of the elements are known, a code list should be used.