DGIWG – 201

NATO Geospatial Information Model (NGIM)

Document Identifier:	STD-13-014-NATO Geospatial Information Model (NGIM)
Publication Date:	18 October 2013
Edition:	**1.0**
Edition Date:	18 October 2013
Responsible Party:	DGIWG
Audience:	DGIWG participants and defence associates and liaisons
Abstract:	This standard provides information on the purpose and structure of data within the NATO Geospatial Information Model (NGIM) part of the NATO Geospatial Information Framework (NGIF).
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Table of Contents

List of Tables

List of Figures

i. Submitting organizations

Nation	Organization
Germany	Bundeswehr Geoinformation Centre (BGIC)
France	Institut Géographique National (IGN)
Sweden	Swedish Armed Forces Geo SE
The Netherlands	Netherlands Defence Geographic Agency
United Kingdom	Joint Forces Intelligence Group - Defence Geographic Centre (JFIG-DGC)
United States	National Geospatial-Intelligence Agency (NGA)

ii. Document contributor contact points

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iii.Revision history

Date	Release	Editors	Primary clauses modified	Description
2013-10-18	1.0	NLD, DEU	All	Editorial changes for publication.

iv.Future work

As the NGIF programme of work continues and business and technical process mature it is expected that the NGIM will evolve and this specification reviewed and updated accordingly.

Introduction

This Standard has been developed as part of the NATO Geospatial Information Framework (NGIF) suite of standards.

The NGIM is an NGIF-wide logical model for geospatial data that is technology neutral. This *Platform Independent Model* determines the syntactic structure. The NATO Geospatial Entity Catalogue (NGEC) is a simplified view on the content using a catalogue structure.

The NATO Geospatial Feature Concept dictionary (NGFCD) provides all Concepts required by NGIM. The NGFCD itself is a profile of the DGIWG Feature Data Dictionary (DFDD).

The NATO Geospatial Real World Index (NGRWI) provides an entry point into the NGIM by providing indexing from names of Real World Phenomena to their implementation in the NGIM.

1 Scope

The NATO Geospatial Information Model (NGIM) specifies an NATO-wide logical model for geospatial data that is technology neutral. This *Platform Independent Model* determines the syntactic structure of the semantics used in the NGIF. From it, using *Model Driven Architecture* (MDA) techniques, technology-tied *Platform Specific Models* (PSM) may be automatically derived and directly employed in system development.

The NGIM conforms to ISO 19109, *Geographic information – Rules for application schema,* and its conceptual schema. It integrates conceptual schemas from multiple ISO 19100-series standards for geospatial information modelling.

The NGIM ensures that there is a clear, complete, and internally-consistent NGIF logical geospatial data model that may be used to derive system-specific implementation models/schemas in a rigorous manner – this ensures that data integrity is preserved when geospatial data is exchanged between different system implementations within the NGIF. It also reduces the cost of evolving system-specific implementations to meet evolving system, mission and customer requirements while promoting data agility.

The NGIM leverages and integrates geospatial information modelling practices from multiple community models (*e.g.,* MGCP, AIXM, ENC, AML, and others) whose data are used and exchanged by NGIF component systems.

ISO 19101, *Geographic information – Reference Model,* defines a feature as an abstraction of real world phenomena. Such abstractions may be represented in information systems using a variety of spatial modelling methods, including representations such as vectors, grids and images. The NGIM supports this breath of geometric representations for “feature data” in the NGIF. The NGIM also supports modelling entities that may represent other geospatially-located information that does not correspond to “real world phenomena”. Unless otherwise specifically stated, the terms *feature* and (modelling) *entity* are used interchangeably in this standard.

Individual items of feature and/or attribute information that are used in the NGIM are specified by the NATO Geospatial Feature Concept Dictionary (NGFCD). Through the NGFCD the NGIM draws upon recognized content standards, specifications and profiles from both the military (*e.g.*, DGIWG, NATO/MGID) and civilian sectors (*e.g.*, IHO, ICAO/EUROCONTROL, WMO).

Real world phenomena are described in the NATO Geospatial Real World Object Index (NGRWI) which can be used as an entry point to the NGIM.

Information traceability is established from concepts in the NGIM to their specification in the supporting NGFCD, and from there back to appropriate authoritative concept sources, where possible, to maximize semantic integrity when geospatial data is exchanged between NGIF-based and external systems. The NGIM, the NGFCD and the NGRWI taken together answer the information exchange questions of “*what do we mean?*” and “*how do we represent it?*”

2 Conformance

The NGIM conforms to ISO 19109, *Geographic information – Rules for application schema,* and its conceptual schema. It integrates conceptual schemas from multiple ISO 19100-series standards for geospatial information modelling

3 Normative references

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.

Table 1: Normative References

Standard or Specification
DGIWG STD-13-019-ed1.0.0 - *NATO Geospatial Information Model (NGIM) – Normative Content* https://portal.dgiwg.org/files/?artifact_id=8627
DGIWG STD-13-016-ed1.0.0 - *NATO Geospatial Feature Concept Dictionary (NGFCD)*
DGIWG STD-13-017-ed1.0.0 - *NATO Geospatial Real World Object Index (NGRWI)*
ISO/TS 19103:2005, *Geographic information – Conceptual schema language*
ISO 19107:2003, *Geographic information – Spatial schema*
ISO 19108:2002, *Geographic information – Temporal schema*
ISO 19109:2005, *Geographic information – Rules for application schema*
ISO 19111:2003, *Geographic information – Spatial referencing by coordinates*
ISO 19112:2003, *Geographic information – Spatial referencing by geographic identifiers*
ISO 19123:2005, *Geographic information – Schema for coverage geometry and functions*
ISO 19115:2003, *Geographic information – Metadata*
OMG Object Constraint Language (OMG OCL), Version 2.2, February 2010

4 Terms, definitions, and abbreviations

4.1 Definitions

The terms and definitions specific to this standard are given in Table 2.

Table 2: Definitions Applicable to this Standard

Term	Definition
Entity	A modelling class that may represent either a feature or other geospatially-located information.
Entity Association	A relationship that links instances of one entity type with instances of the same or a different entity type.
Entity Attribute	A characteristic of an entity.
Feature	An abstraction of real world phenomena.
NGIM	A structured collection of feature information (features, attributes, associations, and ancillary data) whose metamodel conforms to the general feature model as specified in ISO 19109.

4.2 Abbreviations

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

- **AIXM** Aeronautical Information Exchange Model
- **AML** Additional Military Layers
- **DGIWG** Defence Geospatial Information Working Group
- **ENC** Electronic Navigational Chart
- **EUROCONTROL** European Organisation for the Safety of Air Navigation
- **FACC** Feature and Attribute Coding Catalog
- **GML** Geography Markup Language
- **ICAO** International Civil Aviation Organization
- **IEC** International Electrotechnical Commission
- **IHO** International Hydrographic Organization
- **ISO** International Organization for Standardization
- **JGSWG** Joint Geospatial Standards Working Group
- **JMCDM** Joint METOC Conceptual Data Model
- **KML** Keyhole Markup language
- **METOC** Meteorology and Oceanographic
- **MDA** Model Driven Architecture
- **MGCP** Multinational Geospatial Coproduction Program
- **MGID** Military Geographic Information & Documentation
- **MIME** Multipurpose Internet Mail Extension
- **NGEC** NATO Geospatial Entity Catalogue
- **NGFCD** NATO Geospatial Feature Concept Dictionary
- **NGIF** NATO Geospatial Information Framework
- **NGIM** NATO Geospatial Information Model
- **NGRWI** NATO Geospatial Real World Object Index
- **OASIS** Organization for the Advancement of Structured Information Standards
- **OCL** Object Constraint Language
- **OGC** Open Geospatial Consortium
- **OMG** Object Management Group
- **NATO** North Atlantic Treaty Organization
- **PIM** Platform Independent Model
- **PSM** Platform Specific Models
- **SI** International System of Units
- **SKOS** Simple Knowledge Organization System
- **UML** Unified Modeling Language
- **URI** Uniform Resource Identifier
- **W3C** World Wide Web Consortium
- **WMO** World Meteorological Organization
- **XSD** XML Schema Document

5 Logical Structure

5.1 Conceptual Metamodel

The NGIM's conceptual metamodel conforms to the general feature model as specified in ISO 19109, *Geographic information – Rules for application schema*. This metamodel is illustrated in Figure 1**Fehler! Verweisquelle konnte nicht gefunden werden.**. The ISO 19109 metamodel has also been simplified in one regard – GC_FeatureOperation is not used as the specification of any applicable operations is reserved for future NGIM enhancements. Additional classes are added to support the organization and presentation of NGIM content.

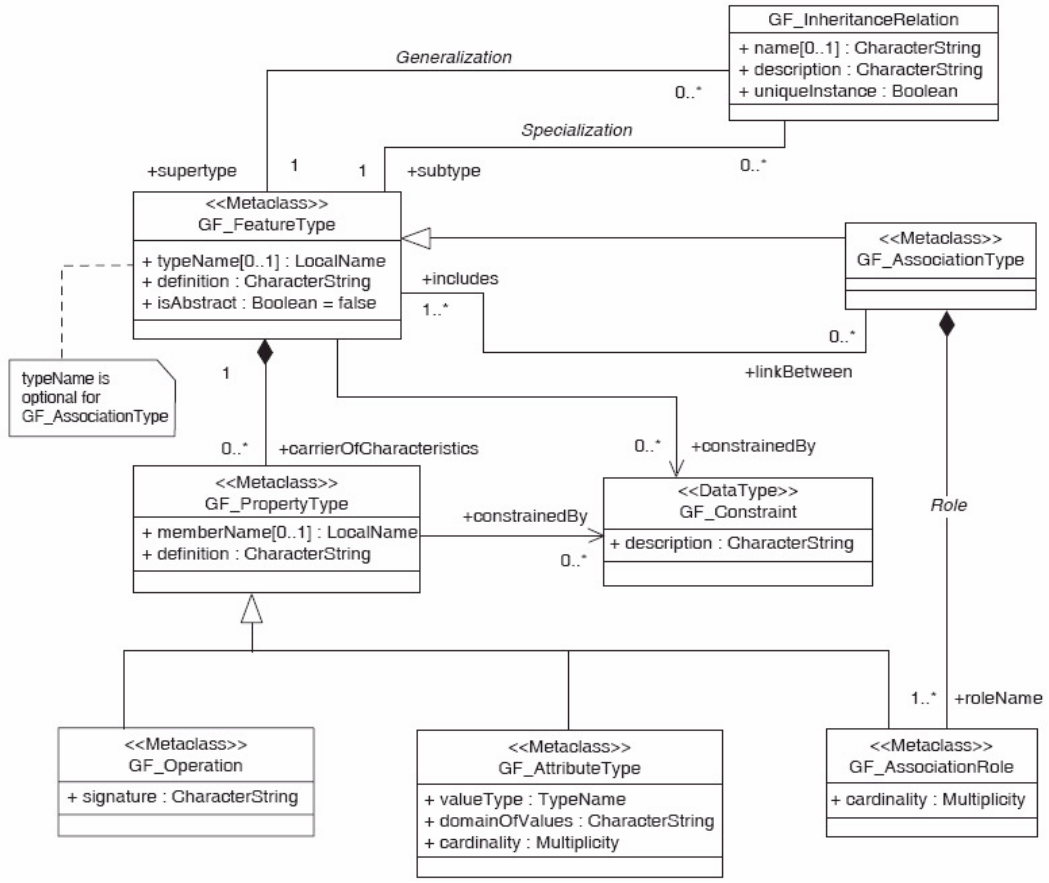


Figure 1: ISO 19109 General Feature Model

As necessary, the metamodel specified in ISO 19109 has been extended based on the object modeling component of *OMG Unified Modeling Language (OMG UML), Superstructure*, Version 2.2, September 2009. In particular, the class and datatype metamodels from the Kernel package have been used for extension guidance. These metamodels are illustrated in Figure 2 and Figure 3, respectively.

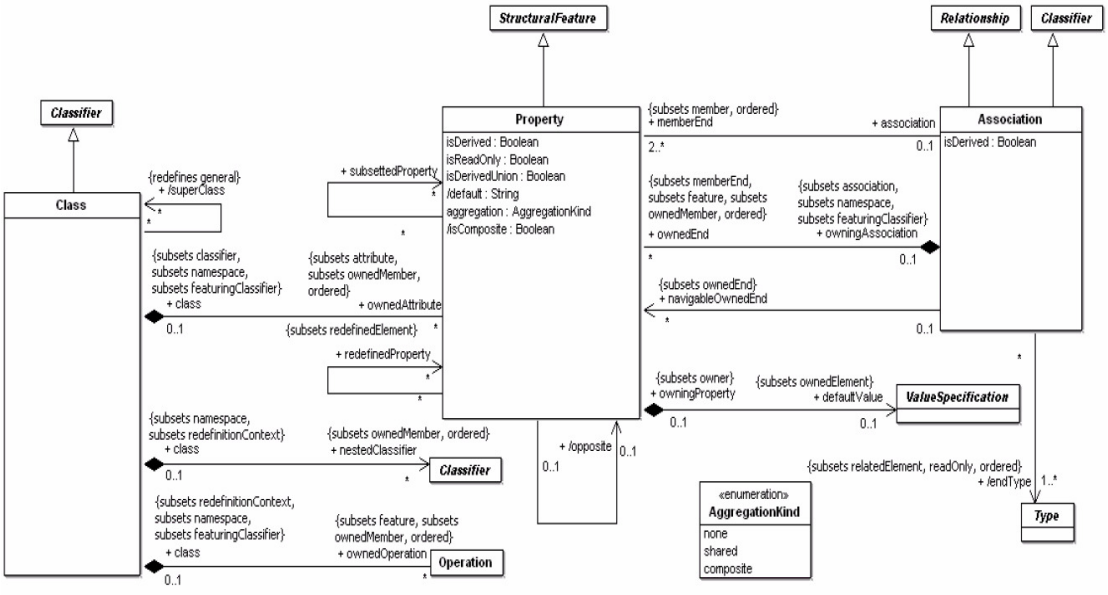


Figure 2: Classes diagram of the UML Superstructure Kernel package (Figure 7.12)

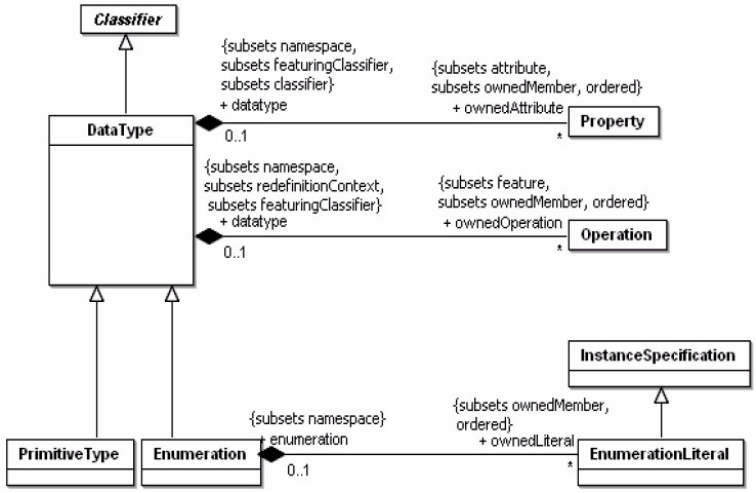
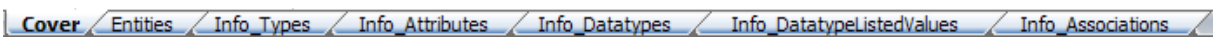


Figure 3: DataTypes diagram of the UML Superstructure Kernel package (Figure 7.13)

5.2 Logical Metamodel

The NGIM logical metamodel is organized as follows. There are basic categories of information modelling constructs.

These are organized in a table structure. The main model is described in the tab “Entities” while all defining and describing information can be found in the “Info_” tables.



Each concept has the following information specified:

1. **AlphaCode:** A unique alphanumeric value that conforms to the DGIWG-developed FDD and may be used to designate this concept for the purposes of data interchange in conformance with DGIWG standards
2. **5-3-1 Code**: A unique alphanumeric value that may be used to designate this concept for the purposes of data interchange within the NGIF in technology-specific limited circumstances.
3. **Name**: A compact and human-readable designator that is used to denote the concept.
4. **Definition**: A precise statement of the nature, properties, scope, or essential qualities of the concept.
5. **Description**: An optional statement of the nature, properties, scope, or non-essential qualities of the concept that are not specified by the definition.
6. **Note**: Additional information regarding the concept, *e.g.*, constraints on creation of instances.

Depending on the type of concept, additional information may be specified. This additional information is specified in the following subsections of this standard.

Constraints identify their applicable Entity Type, and possibly property (Entity Attribute or Association Role), plus two items of information:

1. **OCL Expression**: A well-formed Object Constraint Language (OCL) expression precisely defining the constraint.
2. **Description**: A human-readable description of the constraint that is being applied.

Additionally, there is information documenting the NGIM as a whole.

5.3 Content Rules

Spelling conventions in the NGIM are generally those internationally agreed and adopted by the Defence Geospatial Information Working Group (DGIWG) in their DGIWG Feature Data Dictionary (DFDD). The DFDD uses the *Oxford English Dictionary*, 6th Edition, Version 3.0, as the basis for all spelling.

The preferred units of measure are in accordance with ISO 31 *Quantities and units* (multiple parts).

The presentation of numbers follow U.S. convention in which the period (‘.’) is used as the radix marker (the decimal point”), and the comma (‘,’) is used to delimit groups of three digits to the left of the radix marker.

Additional rules apply to specific types of information for each concept. These are specified in Section 5.4.

5.4 Content Information and Examples

5.4.1 NGIM

The NGIF is represented as a table named “Entities”.

It shows all Entities, their properties and relations.

Information includes:

1. **Name**: A compact and human-readable designator that is used to denote the entity and is derived from the NGFCD (represented in the Info Type Table).
2. **Type:** The Type of information:
    - <empty> for the feature itself
    - **geometry** for the description of the geometry.
    - **attribute** for information on an attribute of the entity.
    - **soc** and **son** for associations
    - **subclassOf** for the relation to a super- or subclass
3. **Property Code**: The Designation of the property/attribute by combining the AlphaCode of the Entity and tha AlphaCode of the Attribute Concept separated by a "."
4. **Modeling Entity Property Name**: Name of the Property as defined in the NGFCD (represented in the Info Attributes Table).
5. **Code:** Depending on the type of information**:**
    - an information on the geometry (point, curve, surface)
    - an AlphaCode of the enumeration value of a enumeration
    - a "+" in the case of a property with a simple datatype.
    - "FeatureEntity" in the case of a inheritance
6. **Multiplicity**: Defining the multiplicity of the property attached to the entity (the times a property is allowed at this entity). A multiplicity starting with "1" defines a mandatory property for the entity.
7. **UoM, Enumerant Name, or Association Information (if applicable)**: Depending on the type of of information either information on
    - a unit of measurement
    - a link to the enumeration value concept
    - a link to the geometry information
    - a link to a super- subclass
8. **Association type or datatype information**: Information on the type of relation to other entities or information about the datatype (e.g. ordering of lists).
9. **UML Stereotype**: Specifies how this Entity Type is stereotyped, *e.g.,* as "featureType".
10. **Constraints and/or Notes**: Information on constraints or notes.

5.4.2 Entity Types

This table represents a excerpt of the NGFCD showing all entity concepts.

1. **AlphaCode:** A unique alphanumeric value that conforms to the DGIWG-developed FDD and may be used to designate this concept for the purposes of data interchange in conformance with DGIWG standards
2. **Name**: A compact and human-readable designator that is used to denote the concept.
3. **Definition**: A precise statement of the nature, properties, scope, or essential qualities of the concept.
4. **Description**: An optional statement of the nature, properties, scope, or non-essential qualities of the concept that are not specified by the definition.

5. **Note**: Additional information regarding the concept, *e.g.*, constraints on creation of instances.
6. **5-3-1 Code**: A unique alphanumeric value that may be used to designate this concept for the purposes of data interchange within the NGIF in technology-specific limited circumstances.

5.4.3 Properties/Attributes

The table Info Attributes represents shows all properties used in the NGIM with more detailed information.

1. **AlphaCode:** A unique alphanumeric value that conforms to the DGIWG-developed FDD and may be used to designate this concept for the purposes of data interchange in conformance with DGIWG standards by combining the AlphaCode of the Entity and the AlphaCode of the Attribute Concept separated by a "."
2. **Name**: A compact and human-readable designator that is used to denote the concept by combining the name of the Entity and the name of the Property separated by a colon ":".
3. **Definition**: A precise statement of the nature, properties, scope, or essential qualities of the property.
4. **Description**: An optional statement of the nature, properties, scope, or non-essential qualities of the property that are not specified by the definition.
5. **Note**: Additional information regarding the property, *e.g.*, constraints on creation of instances.
6. **Multiplicity**: Defining the multiplicity of the property attached to the entity (the times a property is allowed at this entity). A multiplicity starting with "1" defines a mandatory property for the entity.
7. **Constraints**: Information on constraints of the representation of the property, e.g. the ordering.
8. **Datatype AlphaCode**: The AlphaCode to the appropriate datatype used by the property.
9. **Complete**: An indication that if the datatype is an enumeration list the list is complete.
10. **Physical Quantity**: A character string specifying a reference physical quantity for allowed values that may be assigned to the Entity Attribute if its Datatype is based on the Numeric representation.
11. **Measure (Recommended)**: A character string specifying a recommended unit of measure for allowed values that may be assigned to the Entity Attribute if its Datatype is based on the Numeric representation.
12. **Measure (Noncomparable)**: A character string specifying a noncomparable unit of measure for allowed values that may be assigned to the Entity Attribute if its Datatype is based on the Numeric representation. A noncomparable unit of measure is one that is not a strict member of the specified physical quantity, but is related to that physical quantity through a complex context-sensitive computation.
13. **Listed Value Type AlphaCode**: The AlphaCode of the corresponding enumeration value list for the property.

5.4.4 Datatypes

The table Info Datatypes provides detailed information on the used datatypes.

1. **AlphaCode:** A unique alphanumeric value that conforms to the DGIWG-developed FDD and may be used to designate this concept for the purposes of data interchange in conformance with DGIWG standards by combining the AlphaCode of the Entity and the AlphaCode of the Attribute Concept separated by a "."
2. **Name**: A compact and human-readable designator that is used to denote the concept by combining the name of the Entity and the name of the Property separated by a colon ":".
3. **Datatype Element AlphaCode:** The AlphaCode of the Datatype Element in the case of a complex datatype.
4. **Datatype Element Name:** The Name of the Datatype Element in the case of a complex datatype.
5. **Definition**: A precise statement of the nature, properties, scope, or essential qualities of the datatype.
6. **Description**: An optional statement of the nature, properties, scope, or non-essential qualities of the datatype that are not specified by the definition.
7. **Note**: Additional information regarding the datatype.
8. **Multiplicity**: Defining the multiplicity of the datatype element part of the datatype (the times a datatype element is allowed in this datatype). A multiplicity starting with "1" defines a mandatory datatype element.
9. **Constraints**: Information on constraints of the representation of the datatype element, e.g. the ordering.
10. **Datatype Element Datatype**: The Datatype of the datatype element.
11. **Datatype Element and Type Specification**: The specification of the datatype or datatype element.
12. **Complete?**: A Boolean that specifies that in the case of an «enumeration» that the list of Datatype Listed Values is complete.
13. **Length**: A positive integer (*i.e.,* greater than zero) that specifies the maximum length of character string values that may be assigned to the Datatype if it is based on the Text, Key, or Structured Text representations.
14. **Lexical?**: A Boolean value indicating the range of character values that may be used in character string values that may be assigned to the Datatype if it is based on the Text or Structured Text representations.
15. **Structure Specification**: A character string that specifies a scheme of one or more constraints on the structure of the text values that may be assigned to the Datatype if it is based on the Structured Text representation.
14. **Physical Quantity**: A character string specifying a reference physical quantity for allowed values that may be assigned to the Entity Attribute if its Datatype is based on the Numeric representation.
15. **Measure (Recommended)**: A character string specifying a recommended unit of measure for allowed values that may be assigned to the Entity Attribute if its Datatype is based on the Numeric representation.

16. **Measure (Noncomparable)**: A character string specifying a noncomparable unit of measure for allowed values that may be assigned to the Entity Attribute if its Datatype is based on the Numeric representation. A noncomparable unit of measure is one that is not a strict member of the specified physical quantity, but is related to that physical quantity through a complex context-sensitive computation.
17. **Range Minimum**: A value that specifies the minimum end of the range of allowed values that may be assigned to the Datatype if it is based on the Count, Integer or Real representations.
18. **Range Maximum**: A value that specifies the maximum end of the range of allowed values that may be assigned to the Datatype if it is based on the Count, Integer or Real representations.

5.4.5 Listed Values

The table Info DatatypeListedValues represents shows all listed values used in datatypes of the type enumeration used in the NGIM with more detailed information.

1. **Attribute AlphaCode:** A unique alphanumeric value that conforms to the DGIWG-developed FDD and may be used to designate the attribute for the purposes of data interchange in conformance with DGIWG standards by combining a dot (".") with the AlphaCode of the attribute concept.
2. **Domain Name**: A compact and human-readable designator that is used to denote the Enumeration by combining the name of the Entity and the name of the Property.
3. **Value AlphaCode:** A unique alphanumeric value that conforms to the DGIWG-developed FDD and may be used to designate the Listed Value.
4. **Name**: A compact and human-readable designator that is used to denote the Listed Value.
5. **Definition**: A precise statement of the nature, properties, scope, or essential qualities of the Listed Value.
6. **Description**: An optional statement of the nature, properties, scope, or non-essential qualities of the Listed Value that are not specified by the definition.
7. **Note**: Additional information regarding the Listed Value, *e.g.*, constraints on creation of instances.

5.4.6 Associations

The table Info Attributes represents shows all properties used in the NGIM with more detailed information.

1. **Association AlphaCode:** A unique alphanumeric value that conforms to the DGIWG-developed FDD and may be used to designate this association for the purposes of data interchange in conformance with DGIWG standards by combining the AlphaCode of both the Entities.
2. **Association Name**: A compact and human-readable designator that is used to denote the concept by combining the name of both Entities separated by a double slash ("//").

3. **Role AlphaCode**: A unique alphanumeric value that conforms to the DGIWG-developed FDD and may be used to designate this role for the purposes of data interchange in conformance with DGIWG.
4. **Role Name**: A compact and human-readable designator that is used to denote the role.
5. **Definition**: A precise statement of the nature, properties, scope, or essential qualities of the association.
6. **Description**: An optional statement of the nature, properties, scope, or non-essential qualities of the association that are not specified by the definition.
7. **Note**: Additional information regarding the association, *e.g.*, constraints on creation of instances.
8. **Multiplicity**: Defining the multiplicity of the role of the Entity.
9. **Constraints**: Information on constraints of the representation of the role, e.g. the ordering.
10. **Target AlphaCode**: The AlphaCode of the participating Entity in the association.
11. **Target Name**: A compact and human-readable designator that is used to denote a participating Entity in the association.

6 Conformance

6.1 Overview

The NGIM is an NGIF-wide logical model for geospatial data that is technology neutral. The NGIM logical model specifies the geospatial semantic and syntactic structure for the NGIF system-of-systems.

The NGIM is established in order to enable enterprise geospatial information interoperability; Section 6.2 specifies the conditions that must be met to achieve this enterprise-level objective.

Section 6.3 specifies how conformance to the NGIM relates to conformance of other external, military and intelligence standards, and how conformance to the NGIM satisfies geospatial information interoperability preconditions.

Section 6.4 specifies NGIM semantic conformance requirements. These requirements shall be met by all NGIF-participating systems.

Section 6.5 specifies NGIM syntactic conformance requirements. These requirements shall be met by all NGIF-interacting systems.

6.2 Information Interoperability

The NGIM is established in order to enable enterprise information interoperability. It is a necessary but not sufficient precondition to enabling the unambiguous exchange of information within the NATO system-of-systems.

Enterprise information interoperability is enabled when information flows between different systems in the enterprise are in accordance with well-defined system interfaces. These system interfaces are of two types: cross-domain and cross-organization.

Cross-domain information interfaces establish information interoperability between systems containing information from different domains of geospatial in NATO, *e.g.*, interfaces between systems individually dedicated to topographic, boundary, and maritime Safety of Navigation (SoN) information. Although nominally "disconnected" from each other in terms of their geospatial content, in practice there are content overlaps – *e.g.*, in the region of the shore where the land and sea meet, establishing various types of boundaries.

Cross-organization information interfaces establish information interoperability between systems containing information in the same domain(s) of geospatial but which are operated by different organizations.

In practice, a particular inter-system interface often has characteristics of both types, supporting both cross-domain and cross-organization information interoperability.

Interoperable information flow across either type of system interface is enabled when two conditions are met.

1. Each participating system shares the same information model where its domain-content overlaps that of *any other* NGIF-participating system. That is, all pair-wise information model overlaps are non-conflicting – each system uses the same information model for the same geospatial content, regardless of the intended scope/purpose of the particular information system.

   If this condition is met then geospatial semantics are invariant across the enterprise.

2. The unique portion of the information model of each participating system is consistent with its non-unique portion. That is, the unique portion of the information model does not "mean the same thing, but say it differently" – only semantics that are enterprise-unique are allowed.

   If this condition is met then geospatial semantics are invariant across the enterprise.[1]

   Furthermore, those unique semantics should be publicly-specified so that other systems (and their developers/users) can both (a) understand/use them in data discovery and (b) adopt them in the future in response to evolving system requirements.

"Interoperability of semantics" through a well-specified geospatial semantic structure is, however, only part of the interoperability story – it is necessary to also consider the physical encoding of semantics as data structures and patterns in (*e.g.*) electronic systems.

Individual information systems implement geospatial semantic structures internally using physical models and technologies that are determined based on system-specific requirements (*e.g.*, capability, cost, and performance). It is necessary that inter-system information interfaces employ a well-specified physical model (syntactic structure) in order that information ("bits flowing on a wire", or "transferred on a medium") may be successfully exchanged. In particular, in a service-oriented net-centric environment where it

[1] They are invariant because they neither conflict with the non-unique (shared) information model, nor do they overlap (and thus conflict) with each other – else they would already be part of the non-unique information model.

is intended to be able to compose services and orchestrate information flows it is necessary to establish a geospatial syntactic structure suitable to the underlying technology (*e.g.*, an XML schema for use with web services).

Enterprise information interoperability is thus enabled when:

1. All participating systems adhere to a common geospatial semantic structure. This ensures that geospatial-enabled missions "mean the same thing" at all times/places, regardless of whether their underlying information systems are involved in electronic information exchange. This also ensures that geospatial-aware warfighters share and employ the same understanding of geospatial semantics regardless of the mission-context in which that geospatial information is employed.
2. All interacting systems adhere to a common geospatial syntactic structure. This ensures that NGIF-participating information systems "specify geospatial the same way" when they are engaged in electronic information exchange. This specification may vary based on characteristics of the underlying information-exchange implementation technology, but for a given technology it must be fixed.

The NGIM is established in order to specify the common geospatial semantic and syntactic structure for the NATO system-of-systems.

6.3 NGIM Application

6.3.1 Relationship to External Standards

The NGIM conforms to ISO 19109, *Geographic information – Rules for application schema,* and its conceptual schema.

If an information system or data exchange conforms to the NGIM, then it necessarily also conforms to ISO 19109.

The NGIM integrates conceptual schemas from multiple ISO 19100-series standards for geospatial information modelling, such as those for features, events and names (see **Fehler! Verweisquelle konnte nicht gefunden werden.**):

- ISO 19107:2003, *Geographic information – Spatial schema*
- ISO 19108:2002, *Geographic information – Temporal schema*
- ISO 19111:2003, *Geographic information – Spatial referencing by coordinates*
- ISO 19112:2003, *Geographic information – Spatial referencing by geographic identifiers*
- ISO 19123:2005, *Geographic information – Schema for coverage geometry and functions*

If an information system or data exchange conforms to the NGIM, then it necessarily also conforms to the applicable portions of these ISO 19100-series standards.

6.3.2 Relationship to the NGIF Entity Catalog

The NGIM is an NGIF-wide logical model for geospatial data that is technology neutral. This *Platform Independent Model* determines the syntactic structure. The NATO Geospatial Entity Catalogue (NGEC) is a simplified view on the content using a catalogue structure.

For the convenience of developers the semantics described by the NGEC are completely included within the NGIM – developers are often support systems that are both NGIF-interacting (thus need syntactic structure) and NGIF-participating (thus need semantic structure). By combining semantic and syntactic structure into a single integrated standard (see **Fehler! Verweisquelle konnte nicht gefunden werden.**) and accompanying engineering artifacts this eases the cost of NGIF-participating system development and maintenance.

If an information system or data exchange conforms to the NGIM, then it necessarily also conforms to the NGEC.

6.3.3 Model Driven Architecture

From the NGIM, using *Model Driven Architecture* (MDA; see: http://www.omg.org/mda/) techniques, technology-tied *Platform Specific Models* may be automatically derived and directly employed in system development.

NGIM: Platform Independent Model, specifies all information required to generate technology-specific (*e.g.*, Esri Shapefile-based, RDBMS schema-based, and XML Schema-based) encodings using MDA-based processes.

NGIM specifies the common logical model to which each platform-specific model shall conform.

Conformance to NGIM requires that when an information construct from the NGIM is employed within an information system or data set that the meaning and structure of the construct be preserved and that information regarding the corresponding construct that is specified in the NGIM be honoured.

Section 6.5 specifies NGIM syntactic conformance requirements. These requirements shall be met by all NGIF-interacting systems.

6.3.4 NGIM-based Information Interoperability

In the scope of the, NGIM conformance is required in two circumstances, as follows.

1. The information system **participates** in the NGIF by containing geospatial information. geospatial-enabled warfighters (and their information systems) shall share and employ the same understanding of geospatial semantics regardless of the mission-context in which that geospatial is employed.

   All NGIF-participating systems shall conform to the common geospatial semantic structure specified by the NGIM. This is tested by determining either NGIM semantic conformance (see Section 6.4) or NGEC conformance (see Section 6.3.2).

2. The information system, in addition to participating in the NGIF, **interacts** with other information systems in the NGIF by exchanging geospatial information. NGIF-participating information systems shall specify geospatial in an identical manner when they are engaged in electronic information exchange. This specification may

vary based on characteristics of the underlying information-exchange implementation technology.

All NGIF-interacting systems shall conform to the common geospatial syntactic structure specified by the NGIM. This is tested by determining NGIM syntactic conformance (see Section 6.5).

6.4 Semantic Conformance

All NGIF-participating systems shall adhere to the geospatial semantic structure specified by the NGIM. This ensures that geospatial-enabled missions "mean the same thing" at all times/places, regardless of whether their underlying information systems are involved in electronic information exchange. This also ensures that geospatial-aware warfighters share and employ the same understanding of geospatial semantics regardless of the mission-context in which that geospatial is employed.

Section 5.2 et seq. of this standard identifies basic categories of information modeling concept.

The first two types of information are alternative means to denote the modeling concept. Conformance to each of these may be determined as follows:

1. **AlphaCode**: A unique alphanumeric value that conforms to the DGIWG-developed Feature Data Dictionary (DFDD) and may be used to designate this information modelling concept for the purposes of data interchange within the NGIF. When this NGIF alphanumeric code is used in an information system or dataset then the intended semantic structure of the information system or data set information modelling concept shall exactly correspond with the identified NGIM concept. Whereas an information system may use other codes to denote the concept within its boundaries, data sets used in information exchange shall only use either the NGIM-specified or (in technology-specific limited circumstances) the NGIF 531 code.
2. **531 Code**: A unique alphanumeric value that conforms to the DGIWG-developed Feature Data Dictionary (DFDD) and may be used in technology-specific limited circumstances to designate this information modelling concept for the purposes of data interchange in conformance with DGIWG standards. When this NGIF 531 Code is used in an information system or data set then the intended semantic structure of the information system or dataset concept shall exactly correspond with the identified NGIM concept.

The remaining four types of information are primary means of specifying the information modelling concept. Conformance to each of these can only be determined by inspection and, in many cases, subjective judgment.

3. **Name**: A compact and human-readable designator that is used to denote the information modelling concept. Aliases may be defined for use within the scope of an information system, but data sets used in information exchange shall only use the NGIM-specified name.
4. **Definition**: A precise statement of the nature, properties, scope, or essential qualities of the semantic assigned to the information modelling concept. Information systems

and data sets shall preserve this meaning, neither narrowing, broadening, or otherwise altering the specified semantic.

5. **Description**: An optional statement of the nature, properties, scope, or non-essential qualities of the semantic assigned to the information modelling concept that are not specified by the definition. Information systems and data sets should consider this information in their design, implementation, and operations, but explicitly honouring this additional information is optional.
6. **Note**: Additional information regarding the information modelling concept, *e.g.*, constraints on creation of instances. Information systems and data sets should consider this information in their design, implementation, and operations, but explicitly honouring this additional information is optional unless the note states a condition that is therein specified as mandatory.

Depending on the type of concept the NGIM may specify additional information. This additional information is presented in Section 5.4 of this standard and each item of additional information for a concept shall be honoured in both conforming information systems and conforming data sets.

Conformance of Physical Quantities and Units of Measure shall follow the rules established for the twelve basic categories of NGIM concepts.

Constraints on Entity Types (and their properties – either Entity Attributes or Association Roles) shall be honoured by both information systems and data sets.

6.5 Syntactic Conformance

All NGIF-interacting systems shall adhere to the geospatial syntactic structure specified by the NGIM. This ensures that NGIF-participating information systems “specify geospatial the same way” when they are engaged in electronic information exchange. This specification may vary based on characteristics of the underlying information-exchange implementation technology, but for a given technology it must be fixed.

All NGIF-interacting systems are necessarily NGIF-participating, and therefore they shall adhere to the geospatial semantic structure specified by the NGIM (see Section 6.4).

This standard identifies basic categories of information modelling constructs. Each such construct has types of information specified.

- The first two types of information (**AlphaCode**and **531-Code**) are alternative means to denote the modelling construct.

  Conformance to each of these when used to denote the given modelling concept shall be determined as specified in Section 6.4. When these are used to denote a modelling construct then the syntactic structure of that information system or data set information modelling construct shall correspond with the identified NGIM construct. The correspondence shall meet all applicable syntactic requirements (*e.g.*, profiling) expressed by other information regarding the information modelling construct, including both Constraints (expressed in OCL) and Notes (expressed as free-text).

  Whereas an information system may use other denotations for the information modelling construct within its boundaries, data sets used in information exchange

shall only use either the NGIM-specified or (in technology-specific limited circumstances) the DFDD-conformant alphanumeric code.

- The next three types of information (**Name**, **Definition**, and **Description**) are means of specifying the semantics of the information modelling construct. Conformance to each of these is specified in Section 6.4. It is a Recommended Best Practice to adopt the **Name** as specified in the NGIM, however in appropriate circumstances a NGIM-specified alias may be used.
- The final type of information (**Notes**) are a supplemental means of specifying the semantics of the information modelling construct, but may sometimes include "use" information germane to syntactic structure and its valid configurations. Conformance is specified in Section 6.4.

Depending on the type of information modelling construct, the NGIM may specify additional information for each of the categories. This additional information is presented in Section 5 of this standard and each item of additional information for a modelling construct shall be honoured in both conforming information systems and conforming data sets.[2]

Conformance of Physical Quantities and Units of Measure in both information systems and data sets shall follow the rules established.

In some information system or data set environments the primitive Boolean datatype may be unsupported, and instead a Boolean may be represented as a two-valued «codeList», in which case it is necessary to specify its domain as a pair of Datatype Listed Values.

Constraints on Entity Types (and their properties – either Entity Attributes or Association Roles) shall be honoured by both conforming information systems and conforming data set.

[2] Additional conformance criteria are currently being developed. These include guidance for preparing conformant profiles of the NGIM, and specific executable conformance tests for use with NGIF-conformant data sets.