DGIWG 906

METADATA ROADMAP

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Audience:	This document is approved for public release and is available on the DGIWG website, https://www.dgiwg.org/
Abstract:	The activities defined in this document are intended to serve as a guide to facilitate program/project management undertaken by the DGIWG in response to future nation needs. The document places special emphasis on activities that promote interoperability of geospatial data, products, and services. The document is reviewed annually and is subject to change without notice.
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Introduction

Organisations providing geospatial information must enable its discovery, evaluation and use. In today's computerised environment this is typically accomplished through a set of web services, which may interface with multiple networks to allow discovery and retrieval of the information. Successful discovery will depend on the metadata and semantic content[1] of the geospatial information and on the specific functions[2], provided by web services. Search functions are based on specific functional requirements and may be initiated via a variety of semantic enabled mechanisms ranging from structured menus to free text fields.

Metadata (information about a resource) is used to describe and manage resources (e.g. dataset, series, services, etc.) in terms of certain well-defined attributes, such as resource topic category, resource title, or geographic extent of the resource. This description allows users to search for keywords, names and phrases in particular contexts or in structured searches. For example, an organisation's name might be associated with a specific role regarding the data, such as 'responsible party' or 'distributor'. Such associations, combined with the use of 'controlled vocabularies' (i.e. standardised lists of terms, such as abbreviations for countries or code lists for categories) and standardised formats for values (e.g. for dates or geographic extents) can greatly improve the efficiency of discovery, evaluation and ultimately knowledge about the information.

Metadata is also used within knowledge management, to retain, share and build on data gaining further insight from the increasing larger and complex data holdings that is outside of timely processing capabilities of a human operator.

Efficiency in retrieving relevant and accurate information and knowledge is critical to the decision maker. To improve the discovery, evaluation and use of information or knowledge within and among the allied nations, the metadata descriptions of the various resources must ideally share a common form and meaning. With the increasing number of types and sources of geospatial information and the multitude of discovery and exploitation tools available, the defence community will increasingly require standardised metadata terminology and an ability to capture, manage and reuse metadata concepts (e.g. code lists, metadata elements). The Defence community will increasingly require to be able to be interoperable with semi and unstructured metadata terminological structures. To address this need, the military community will leverage and use, to the largest degree practical, geographic standards from the ISO 19XXX portfolio.

[1] Expressing the complexity of interrelations in human knowledge

[2] Functions such as Web Mapping Service, Web Processing Service, and other encoding functions, support of knowledge management like information quality.

i. Contributing participants

Nation	Parent organisation
Austria	Federal Ministry of Defence
Australia	Defence GEOINT Standards Office (GSO)
Denmark	The Danish Agency for Data Supply and Efficiency (SDFE)
France	Institut National de L'Information Géographique et Forestière (IGN)
Netherlands	Defence Geographic Agency (DGA)
United Kingdom	Joint Geospatial Intelligence (JGI)

ii. Document points of contact

All questions regarding this document shall be directed to the secretariat@dgiwg.org

iii. Revision history

Date	Edition number	Primary clauses modified	Description
2014-11	WD		Initial Working Draft. The document is a revision of the 'DGIWG Metadata Vision, Ed. 1.3.2, published 2013.'
2015-10	FD		Final Draft approved by DGIWG Technical Panel, September 2015, and submitted for publication.
2015-12	2.0.0		Published Date
2016-12	2.1 WD		Working Draft 2.1
2017-01	2.1 FD		Final Draft approved by DGIWG Technical Panel, March 2017.
2017-12	2.2 WD		Working Draft 2.2
2018-03	2.2 FD		Final Draft approved by DGIWG Technical Panel, April 2018.
2018-05	2.3 WD		Working Draft 2.3.
2019-05	2.3		Working Draft 2.3, Update.
2019-10	2.3 FD		Final Draft 2.3.

1. Scope

This document serves as a strategy and planning tool for the DGIWG, its member organisations and associates. It provides the basis by which one is able to capture and address standardisation deficiencies in the area of metadata. It describes the present state of geospatial interoperability across the civil and defence user communities and establishes future state goals and objectives by which associated standardisation activities are based. Key factors included: user requirements, relevant standards (published or in work), and emerging technologies.

2. Purpose

DGIWG is the multi-national body responsible for providing advice and policy recommendations on geospatial standardisation issues to the national defence organisations of its member nations. A key objective of the DGIWG is to promote and facilitate standards-based solutions, which facilitate the efficient exchange and interoperability of geospatial information for those nations engaged in coalition exercises and operations.

DGIWG work on geospatial standards includes metadata for geospatial information. The mission of metadata activities within DGIWG is to enable appropriate documentation (in an interoperable manner) of geospatial information in the context of a military system. This documentation is based on international standards, and to enable efficient generation and management of metadata via a DGIWG centralised information point. The benefactors from DGIWG metadata activities are DGIWG nations and associates (e.g. MGCP, NATO, EUMS, etc.), defence industry and the general military community.

3. References

3.1. ISO references

Please note that some ISO standards listed here have been withdrawn. They are still used within DGIWG Metadata panel for practical reasons.

1) ISO 639-2:2016, Codes for the representation of names of languages - Part 2: Alpha-3 code
2) ISO 3166-1:2013, Codes for the representation of names of countries and their subdivisions – Part 1: Country codes
3) ISO 8601: 2004, Data elements and interchange formats -- Information interchange -- Representation of dates and times
4) ISO 15836: 2009, Information and documentation – The Dublin Core metadata element set
5) ISO/TS 19103:2015, Geographic information – Conceptual schema language
6) ISO 19107:2003, Geographic information – Spatial Schema
7) ISO 19108:2002 and Cor1:2006, Geographic information – Temporal schema
8) ISO 19109:2015, Geographic information -- Rules for application schema
9) ISO 19110:2005 and AMD.1:2011, Geographic information – Methodology for feature cataloguing (Replaced by ISO 19110:2016)
10) ISO 19110:2016, Geographic information -- Methodology for feature cataloguing
11) ISO 19113[3]:2002, Geographic information – Quality principles

12) ISO 19114[1]:2003, Geographic information -- Quality evaluation procedures

13) ISO 19115[1]:2003, Geographic information -- Metadata

14) ISO 19115-1:2014, Geographic information --- Metadata – Part1: Fundamentals

15) ISO 19115/Cor.1:2006, Geographic information -- Metadata, Technical Corrigendum 1

16) ISO 19115-2:2009, Geographic information -- Metadata – Part2: Extensions for imagery and gridded data (under revision process)

17) ISO/TS 19115-3:2016, Geographic information -- Metadata -- Part 3: XML schema implementation for fundamental concepts

18) ISO 19119:2005 and AMD1:2008, Geographic information - Services (replaced by ISO 19119:2016)

19) ISO 19119:2016, Geographic information - Services

20) ISO/TS 19130:2010, Geographic information - Imagery sensor models for geopositioning

21) ISO/TS 19130-2:2014, Geographic information -- Imagery sensor models for geopositioning -- Part 2: SAR, InSAR, lidar and sonar

22) ISO 19135:2005, Geographic information -- Procedures for item registration (replaced by ISO 19135-1:2015)

23) ISO 19135-1:2015, Geographic information -- Procedures for item registration -- Part 1: Fundamentals

24) ISO/TS 19135-2:2012, Geographic information -- Procedures for item registration -- Part 2: XML schema implementation

25) ISO/TS 19138[1]:2006, Geographic information -- Data quality measures

26) ISO/TS 19139:2007, Geographic information -- Metadata - XML schema implementation (partly replaced by ISO 19115-3:2016)

27) ISO/TS 19139-1: 2019, Geographic information -- Metadata – XML schema implementation

28) ISO/TS 19139-2:2012, Geographic information -- Metadata - XML schema implementation - Part2: Extensions for imagery and gridded data

29) ISO 19157:2013, Geographic information -- Data quality

30) ISO/TS 19157-2:2016, Geographic information -- Data quality -- Part 2: XML schema implementation

3.2. OGC standards

1) OGC 07-006r1, CSW 2.0.2**,** OpenGIS® Catalogue Services Specification 2.0.2, OGC, 2007

2) OGC 07-045, CSW 2.0.2 ISO AP, OpenGIS® Catalogue Services Specification 2.0.2 - ISO Metadata Application Profile, Version 1.0, OGC, 2007

3) OGC 07-110r4, CSW 2.0.2 ebRIM AP, CSW-ebRIM Registry Service - Part 1: ebRIM profile of CSW, Version 1.0.1, OGC, 2009

4) OGC 13-084r2, OGC I15 (ISO19115 Metadata) Extension Package of CS-W ebRIM Profile 1.0, OGC, 2014

3.3. W3C standards

1) W3C/OGC Spatial Data on the Web Best Practises**,** September 2017

2) W3C: RDF, Resource Description Framework

3) W3C: OWL, Web Ontology Language

3.4. DGIWG standards

1) DGIWG 125 – Defence Profile of OGC's Catalogue Service for the Web 2.0, Edition 1.0.1, 01 March 2018
2) RFC 6288 - DGIWG namespace from IETF

3.5. NATO Standards

1) NATO STANAG 2586, NATO GEOSPATIAL METADATA PROFILE
2) NATO STANAG 2592, NATO GEOSPATIAL INFORMATION FRAMEWORK (NGIF)
3) NATO STANAG 6523, GEOSPATIAL WEB SERVICES
4) NATO GIS Vision and Strategy

3.6. Other standards

ebRIM, *ebXML Registry Information Model, Version 3.0, OASIS Standards, 2 May 2005*
http://docs.oasis-open.org/regrep-rim/v3.0/

4. Terms, definitions, and abbreviations

4.1. Definitions

4.1.1. Application Programming Interface

an interface definition that permits invoking services from application programs without knowing details of their internal implementation

[OGC Glossary of Terms]

4.1.2. Catalogue

collection of items or an electronic or paper document that contains information about the collection of items

[ISO 10303-227:2005, definition 3.3.10]

4.1.3. Classification Scheme

descriptive information for an arrangement or division of objects (things) into groups based on criteria such as characteristics, which the objects (things) have in common.

[ISO/IEC 11179:2013/AMD 1:2020, 3.2.16]

4.1.4. Concept

unit of knowledge created by a unique combination of characteristics

[ISO 1087:2019]

4.1.5. Dataset

identifiable collection of data

[ISO 19115-1:2014]

4.1.6. Dataset series

collection of datasets sharing common characteristics

[ISO 19115-1:2014]

4.1.7. Linked Data

collection of interrelated resources on networks

[W3C]

4.1.8. Metadata

information about a resource

[ISO 19115-1:2014]

4.1.9. Namespace

collection of names, identified by a URI reference, which are used in XML documents as element names and attribute names

[W3C XML]

4.1.10. Ontology

formal representation of phenomena of a universe of discourse with an underlying vocabulary including definitions and axioms that make the intended meaning explicit and describe phenomena and their interrelationships

[ISO 19101-1:2014, 4.1.26]

4.1.11. Profile

set of one or more base standards or subsets of base standards, and, where applicable, the identification of chosen clauses, classes, options and parameters of those base standards that are necessary for accompanying a particular function.

[ISO 19106:2004]

4.1.12. Register

set of files containing identifiers assigned to items with descriptions of the associated items

[ISO 19135-1:2015]

4.1.13. Registry

information system on which a register is maintained

[ISO 19135-1:2015]

4.1.14. Resource

identifiable asset or means that fulfils a requirement

[ISO 19115-1:2014]

EXAMPLES: Dataset, dataset series, service, document, activity, software, person or organisation.

4.2. Abbreviations

1) ADatP Allied Data Processing Publication
2) AMD Amendment
3) AML Additional Military Layers
4) ANZLIC Australia and New Zealand Spatial Information Council
5) AP Application Profile

6)	API	Application Programming Interface
7)	CEN	European Committee for Standardization
8)	CRS	Coordinate Reference System
9)	CSD	Coalition Shared Data
10)	CSV	Comma Separated Values
11)	CSW	Catalogue Service for the Web
12)	DCAT	Data Catalogue Vocabulary
13)	DFDD	DGIWG Feature Data Dictionary
14)	DGIF	Defence Geospatial Information Framework
15)	DGIWG	Defence Geospatial Information Working Group
16)	DMF	DGIWG Metadata Foundation
17)	DWG	Domain Working Group
18)	ebRIM	electronic business Registry Information Model
19)	EPSG	European Petroleum Survey Group
20)	ETL	Extract, Transform and Load
21)	EU	European Union
22)	EUMS	European Union Military Staff
23)	FMN	Federated Mission Networking <NATO>
24)	GIR	Geospatial Information Requirement
25)	GISMO	Geospatial Information to Support decision Making in Operations
26)	GML	Geography Markup Language
27)	GMTI	Ground Moving Target Indicator
28)	GPKG	GeoPackage
29)	IANA	Internet Assigned Numbers Authority
30)	ICAO	International Civil Aviation Organization
31)	IEC	International Electrotechnical Commission
32)	IETF	Internet Engineering Task Force
33)	IHO	International Hydrographic Organization
34)	IMWG	Imagery Working Group
35)	InSAR	Interferometric Synthetic Aperture Radar
36)	INSPIRE	Infrastructure for Spatial Information in the European Community
37)	IPHG	International Program for Human Geography
38)	IR	Infrared
39)	ISO	International Organization for Standardization
40)	ISR	Intelligence, Surveillance and Reconnaissance
41)	JCGISR	Joint Capability Group on Intelligence, Surveillance and Reconnaissance
42)	JGSWG	Joint Geospatial Standards Working Group
43)	JSON	JavaScript Object Notation
44)	JSON-LD	JavaScript Object Notation for Linked Data
45)	KOS	Knowledge Organization Systems
46)	LIDAR	Light Detection and Ranging
47)	MDR	Metadata Registry
48)	MGCP	Multinational Geospatial Co-Production Program

49) MI Motion Imagery
50) MT02 Metadata Register Maintenance Team
51) NCDF NATO Core Data Framework
52) NCIA NATO Communications and Information Agency
53) NCMS NATO Core Metadata Specification
54) NGIF NATO Geospatial Information Framework
55) NGMP NATO Geospatial Metadata Profile
56) NIIA NATO Intelligence, Surveillance and Reconnaissance (ISR) Interoperability Architecture
57) NMF NSG Metadata Foundation
58) NMRR NATO Metadata Registry and Repository
59) NNEC NATO Network Enabled Capability
60) NSG National System for Geospatial Intelligence
61) NSILI NATO Standard ISR Library Interface
62) OASIS Organization for the Advancement of Structured Information Standards
63) OECD Organisation for Economic Co-operation and Development
64) OGC Open Geospatial Consortium
65) OSM Open Street Map
66) OWL Web Ontology Language
67) RDF Resource Description Framework
68) Rev Revision
69) RFC Request for Comments
70) SAR Synthetic Aperture Radar
71) SHACL Shapes Constraint Language
72) SKOS Simple Knowledge Organization System
73) SRD Standards Related Document
74) STANAG Standardization Agreement
75) TC Technical Committee
76) TRD Technical Reference Document
77) TREx TanDEM-X High Resolution Elevation Data Exchange
78) TS Technical Specification
79) UML Unified Modeling Language
80) UN United Nations
81) VMST Vector Models and Schema Team
82) W3C World Wide Web Consortium
83) WMO World Meteorological Organization
84) WSTP Web Services Technical Panel
85) XMG XML Maintenance Group <ISO>
86) XML Extensible Markup Language
87) XNDR XML Naming and Design Rules
88) XSD XML Schema Definition
89) XSL eXtensible Stylesheet Language
90) XSLT eXtensible Stylesheet Language Transformation

5. Metadata Standardisation – present state

5.1. Civil

5.1.1. ISO TC211 Metadata Standards

DGIWG metadata work is based on ISO TC211 metadata standards. The following paragraphs present “generation 1” and “generation 2” of ISO standards related to metadata only.

These standards include both abstract/conceptual standards and implementation/encoding standards. These content standards use UML conceptual diagrams to illustrate the relations among metadata elements and a schema to define the element conditionality, data type, and domains. Implementation standards define implementation in XML.

The definitions for generation 1 and 2 are included in the following sections.

5.1.1.1. Mature Metadata Standards: generation 1

What is Generation 1?

The standards cited below constitute a set of mature metadata standards, referred to as “generation 1” in this document. These standards cross-reference concepts from one another and should be used as a common set of standards when addressing metadata requirements and solutions.

1) ISO 19110:2005 defines the methodology for cataloguing feature types and specifies how the classification of feature types is organised into a feature catalogue and presented to the users of a set of geographic data. This version is applicable to the definition of geographic features at the type level. This version is not applicable to the representation of individual instances of each type and excludes spatial, temporal and portrayal schemas.

2) ISO 19111:2003 defines the conceptual schema for the description of spatial referencing by coordinates. ISO 19111:2007 superseded the 2003 version. The 2007 version has added coordinate reference system (CRS) that do not change with time and enables CRS defined on moving platforms such as cars, ships, aircraft and spacecraft. Note: the transformation to an Earth-fixed CRS can include a time element.

3) ISO 19113:2002 established the principles for describing geographic data quality and outlines the parts for reporting quality information. ISO 19113 is applicable for information producers to describe and asses how well a dataset (quality) meets its mapping of the universe of discourse as specified in the product specification, formal or implied, and for data users to understand if the specific geographic data is of sufficient quality for a particular application.

4) ISO 19114:2003 outlined a quality evaluation procedures framework for determining and evaluating quality that is applicable to digital geographic datasets, consistent with ISO 19113:2002.

5) ISO 19138:2006 defined a set of data quality measures. These are used when reporting data quality for sub elements identified in ISO 19113:2002. ISO 19138:2006 specifies the structure of data quality measures and provides a set of standardised measures within a register.

6) ISO 19115:2003 (and its corrigendum 1 (2006)) specifies a conceptual schema for geospatial information metadata organised into several metadata sections (e.g. identification, quality, constraints, etc.). It includes a quality UML Model based on ISO 19113 and ISO 19114 structure.

7) ISO 19119:2005 extends ISO 19115 and defines a full conceptual schema for geospatial services and its metadata. It is the reference metadata standard for geospatial services.

8) ISO 19115-2:2009 extended ISO 19115:2003/2006 to supporting imagery and gridded data metadata specific requirements.

9) ISO/TS 19139:2007, Geographic information - XML schema encoding Implementation. As ISO 19115 does not provide any encoding, the actual implementation of geographic information metadata could vary based on the interpretation of metadata producers. To facilitate the standardisation implementations, this metadata implementation specification provides a definitive, rule-based encoding when applying ISO 19115.

10) ISO 19139-2:2012, extends this rule encoding specification to include Imagery and gridded data in line with ISO 19115-2.

11) ISO 19130:2010 (Imagery Sensor Models) identifies the information required to determine the relationship between the position of a remotely sensed pixel in image coordinates and its geoposition.

12) ISO 19130-2:2014 supports exploitation of remotely sensed images. It specifies the sensor models and metadata for geopositioning images remotely sensed by SAR, InSAR, lidar and sonar sensors.

13) The conceptual schema for geospatial metadata defined through ISO 19115, ISO 19115-2 and ISO 19119 are based on the following foundation standards:

    a. ISO/TS 19103 defines the conceptual schema language and specifies a set of basic types widely used in the ISO 19100 series of standards;

    b. ISO 19107 defines a set of geometric primitives used in ISO 19115, for example, to describe the spatial extent of a metadata resource; and

    c. ISO 19108 defines a set of temporal primitives used in ISO 19115, for example, to describe the temporal extent of a metadata resource, all of which reference;

    d. ISO 8601 defines the expression of dates and times.

14) The implementation of ISO 19115, ISO 19115-2 and ISO 19119 involves the implementation of those foundation standards (19103, 19107 and 19108).

5.1.1.2. New Metadata Standards: generation 2

What is Generation 2?

As “generation 1” standards reference each other, the revision of some of them implies the need to revise the whole set of standards, leading to the establishment of a “generation 2” set.

1) ISO 19110:2016 which defines the structure of a feature catalogue (entity/attributes) that can be referred to within an ISO 19115/ISO 19115-1 record. Superseding its 2005 version, with the inclusion of additional capabilities to manage multilingualism in feature catalogues.

2) ISO 19111:2019, Geographic information – Spatial referencing by coordinates, supersedes the 2007 version and incorporates the provision of ISO 19111-2:2009 which has been cancelled. The main changes in the 2019 edition to the previous edition are:

    a. Consolidation of the provisions of ISO 19111-2:2009 (Spatial referencing by coordinates – Extension for parametric values), with;

    b. Extensions to describing dynamic geodetic reference frames, geoid-based vertical coordinate reference systems and three-dimensional projected coordinate reference systems,

    c. Remodelling of the metadata elements scope and extent,

    d. Addition of requirements to describe coordinate metadata and the relationship between spatial coordinates.

3) ISO 19157 – Data Quality, published in 2013, updated with an Amendment in 2018, revises, merges and harmonises the quality standards ISO 19113, Quality Principles, ISO 19114, Quality evaluation procedures and ISO 19138, Data Quality Measures.

   During the revision of ISO 19115-2, it has been stated that the coverage result part should go into ISO 19157. An amendment to ISO 19157 has been published to include this part. (Its name is; AMD. 1: Geographic information -- Data Quality -- Amendment 1:2018). The 2018 AMD. 1, also includes reference to ISO 19135-1: 2015, Geographic information – Procedures for item registration – Part 1: Fundamentals

4) ISO 19157-2:2016 defines the XML implementation for ISO 19157:2013.

5) ISO/TS 19138. An XML schema implementation derived from ISO 19157:2013 and the data quality related concepts from ISO 19115-2.

6) ISO 19115, its corrigendum and the service metadata model of 19119:2005 have been revised into the new ISO 19115-1 Metadata Fundamentals, published in 2014. The revision of ISO 19115 to ISO 19115-1:2014/AMD 1: 2018 revises ISO 19115-1 to account for the extension/addition requirements of 19115-2:2016 metadata.

7) ISO 19119 was revised without metadata elements definitions[4], as they have been included in ISO 19115-1, in 2016. ISO only includes service specification definition yet references service metadata for Application Programming Interfaces and Linked Data.

8) ISO 19115-2:2019, the scope of this standard has been redefined as “acquisition and processing metadata” during the last revision. An amendment is currently being published.

9) ISO 19115-3:2016 partly replaces ISO/TS 19139:2007 and is superseding ISO/TS 19139-2:2012, ISO/TS 19115-3:2016, defines the XML schema implementation for ISO 19115-1 and ISO 19115-2. It includes a resource XSLT transformation to ease the migration from ISO 19115 to 19115-1. All ISO 19139:2007 XML can be translated to ISO 19115-3 without content loss.

10) ISO/TS 19139-1:2019 – XML encoding rules supersedes ISO/TS 19139:2007, without metadata. It defines XML based encoding rules for conceptual schemas specifying types that describe geographic resources. Note: The encoding rules in this standard are not applicable for encoding UML application schemas for geographic features (see ISO 19136:2007 – Geographic Information – Geography Markup Language, for those rules).

    a. It may be provided as a sensor description with the associated physical and geometric information necessary to rigorously construct a Physical Sensor Model (PSM).

    b. It can be provided as a True Replacement Model (TRM), using functions whose coefficients are based on a PSM so that they provide information for precise geopositioning. Including the calculation of errors, as precisely as the PSM they replace.

    c. It may be provided as a Correspondence Model providing a functional fitting based on observed relationships between the geopositions of a set of ground control points and their image coordinates.

    d. It may be provided as a set of ground control points that can be used to develop a Correspondence Model or to refine a PSM or TRM.

11) ISO 19139-2 defines the XML schema implementation of ISO 19115-2. To allow the use of ISO 19115-2 metadata elements with ISO 19115-1 metadata element before ISO 19115-2 rev is published, ISO/TS 19115-3:2016 has also included this encoding.

[4] ISO 19119:2016 (CSW 3.0 references ISO 19119: 2005 and 19101:2002) refers to its relationship with ISO 19101-1:2014, where metadata is outlined as a component part of the reference model.

12) ISO 19165-1:2018 – Fundamentals of preservation, defines the requirement for the long-term preservation of digital geospatial data. Data includes metadata, representation information, provenance, context and any other content items that capture the knowledge that are necessary to fully understand and reuse the archived data. Geospatial data is preserved as a geospatial information package.

5.1.1.3 Migration from generation 1 to generation 2

DMF 1.0 was based solely on generation 1 standards, but DMF 2.0 also includes the generation 1 and 2 concepts.

Care has been taken in the establishment of generation 2 standards, to maintain conceptual backward compatibility with generation 1 standards.

The migration from ISO 19115:2003 to the revised ISO 19115-1:2014 is thought to be a migration from generation 1 to generation 2, which means to migrate from the set (ISO 19115 + ISO 19115-2 + ISO 19119) to the set (ISO 19115-1 + ISO 19157 + ISO 19115-2:2019).

Annex H of ISO 19115-1 describes modifications applied in the UML model from ISO 19115 to ISO 19115-1. This work has not been done for the data quality model and was transferred to ISO 19157:2013.

The following figure illustrates changes between these two ISO generations.

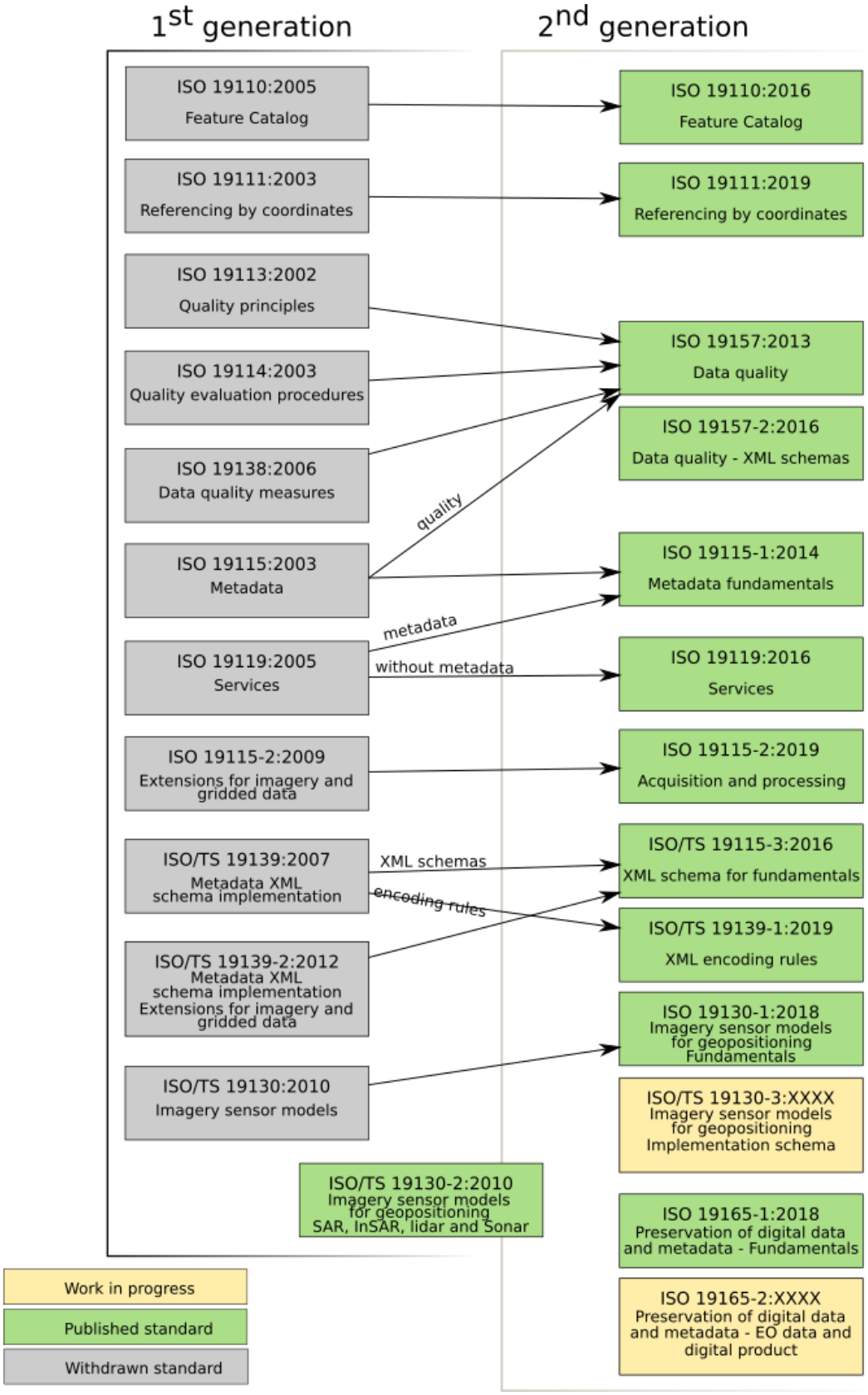

Figure 1 : Generation 1, 2 and their differences (Diagram of the evolution of ISO metadata standards)

5.1.2. ISO TC211 Metadata Implementation (Encoding) Standards

ISO encoding standards specify the XML format and rules used to create and validate the output metadata records.

ISO/TS 19139 defines a set of encoding rules which can generally be applied to any of the spatial conceptual standards. It proposes an XML Schema Implementation of ISO 19115 and the parts of the conceptual foundation standards involved when implementing ISO 19115. ISO/TS19139 has been superseded by ISO 19139-1 and ISO 19115-3. Schemas are available here: https://standards.iso.org/iso and https://schemas.isotc211.org/.

The ISO TC211 XML Management Group has developed several transforms that facilitate migration of metadata from ISO 19139 to ISO 19115-3. These transforms are freely available and can be downloaded from the ISO website: http://standards.iso.org/iso/19115/resources/transforms/ISO19139.

No encoding was originally provided by ISO for the previous version of the ISO 19119 standard. It was generated by OGC in the OGC 07-045 document. Now that service metadata elements are included in ISO 19115-1, the encoding is included in ISO/TS 19115-3:2016.

OGC 07-045r1, CSW 2.0.2 ISO AP and its Corrigendum proposes an XML Schema Implementation of ISO 19119 based on ISO/TS 19139:2007 encoding rules. ISO/TS 19139 also proposes a standard encoding of Coordinate Reference System catalogues, unit of measures catalogues, and code list catalogues.

ISO TC211 XML Maintenance group (XMG) has stated that XML encodings should not be part of separate standards but should be included as an annex of the conceptual standard. Thus, ISO 19110:2016 for example includes an annex referencing the XML schemas.

5.1.3. Other Metadata Initiatives

5.1.3.1. Dublin Core

Dublin Core is an international initiative focusing on the discovery aspect of metadata for general information. The initiative has gained a broad cross-sectoral support. The Dublin Core Metadata Element Set was published as ISO 15836:2009[5] and was confirmed in 2014 as a standard.

The wide use of Dublin Core does not limit the importance of sector-specific metadata standards such as ISO 19115[6]. Metadata repositories of spatial resources are generally not set up to address discovery-only requirements and Dublin Core metadata elements will not satisfy the wide range of requirements of the geo communities.

However, the interface between Geospatial-Intelligence community and the rest of the military communities has to be considered. It is fundamental that the existence of the geospatial resources be known by non-geographers. In this respect, Dublin Core certainly has a role to play. Indeed, it provides a core set of general metadata elements, all of them having a mapping with ISO 19115 so with geo metadata standards. For this reason, Dublin Core is taken into account for DGIWG metadata.

[5] ISO 1586-1:2017 is the most recent update of this standard and a Part 2 covering several dozen properties and classes have been added to the Namespace is expected in 2019.
[6] In CEN (European Committee for Standardization) a mapping/extension of Dublin Core has been made with the purpose of handling geographic information. This initiative has been abandoned with the development of INSPIRE.

5.1.3.2. Federal Geographic Data Committee (FGDC) (US)

The FGDC (Federal Geographic Data Committee) is a United States of America (USA) inter-ministerial body, responsible for assisting in the development and implementation of the objectives of the executive order to develop, implement, and promote standards.

The FGDC NSDI (National Spatial Data Infrastructure) is the national infrastructure for US geographic information. This initiative consists of the following complementary components:

1) the development of a network, largely computerised, facilitating the sharing of spatial data resources (Clearinghouse);
2) the development of mechanisms for producers to describe the data they hold through metadata; and
3) the definition of the base fabric geographic information to be widely available to potential users.

5.1.3.2.1. Content Standard for Digital Geospatial Metadata (CSDGM)

The specification of the FGDC metadata content, the CSDGM (Content Standard for Digital Geospatial Metadata, 1998), has become a reference standard recognised by many nations. However, its use is no longer recommended within FGDC, which promotes migration to ISO standards.

This work does not influence DGIWG metadata works and there have not been any requirement/need to provide a mapping/transformation between CSDGM and DMF.

5.1.4. Open Geospatial Consortium

5.1.4.1. Catalogue Service for the Web (CSW) specification: (Metadata)

OGC 07-006r1, CSW 2.0.2[7] is the reference service specification for discovery, evaluation, and use. It proposes an XML encoding based on a profile of Dublin Core which is suitable for discovery. More generally, a service compliant to the base OGC 07-006r1, CSW 2.0.2 will address discovery requirements. It is necessary to use OGC 07-006r1, CSW 2.0.2 application profiles to go further:

1) OGC 07-045, CSW 2.0.2[8] is an ISO 19115/ISO 19139 application profile of OGC 07-006r1, CSW 2.0.2. It is based on an ISO/TS 19139 compliant encoding of ISO 19115 and ISO 19119. It addresses evaluation requirements and is applicable in this context.
2) DGIWG has created a Defence profile of the OGC's Catalogue Service for the Web 2.0, based on both OGC documents OGC 07-045r1 and 07-006r1r1.
3) The CSW-ebRIM Registry Service defines an application profile of OGC 07-006r1, CSW 2.0.2 based on the ebRIM information model. ebRIM is a generic metamodel standardised in the OASIS (Organization for the Advancement of Structured Information Standards) consortium that can be instantiated for the discovery of various types of resources: metadata, sensor descriptions, feature catalogues, services, etc. These instances must be standardised in Extension Packages. An Extension Packages for ISO 19115/19119 (I15) and Earth Observation metadata have also been published.

   DMF requires technical review ensuring ebRIM alignment to comply with DGIWG 125 (Defence Profile of OGC's Catalogue Service for the Web 2.0, Ed 1.0.1)[9]

[7] http://portal.opengeospatial.org/files/?artifact_id=20555
[8] https://portal.opengeospatial.org/files/?artifact_id=77855
[9] https://portal.dgiwg.org/files/?artifact_id=68270&format=pdf

OGC 12-168r6, CSW 3.0[10] was published in 2016 but an application profile is not yet available. CSW 3.0 introduces terms like “metadata entity” yet not “entity”, which is outlined in ISO 19119:2016. A DGIWG metadata understanding is needed confirming its technical position with a concept like “entity” (ISO definition: “something that has separate and distinct existence and objective or conceptual reality”) in relation to metadata.

5.1.4.2. Earth Observation Metadata profile of Observations & Measurements

This OGC metadata specification has been developed by the ESA (European Space Agency), based on ISO 19156:2011-Geographic information -- Observations and measurements (O&M2.0), which defines a model for Earth Observation and Measurements. It addresses metadata requirements to describe earth observation data. The implementation is based on GML. This work has been taken into account for the definition of the DMF sensor metadata elements.

5.1.4.3. Metadata and Catalogue Domain Working Group

Metadata and Catalogue DWG is the result of the merger between the Metadata DWG and Catalogue DWG groups (the charter is still being discussed).

It is a discussion forum on the theme of metadata and catalogues.

https://www.ogc.org/projects/groups/metacatdwg

It is used to inform on the work in progress at the OGC and to exchange on the work and software developments related to metadata and catalogue in specific organisations or domains, in particular those based on the OGC Catalogue Service standard and its ISO and ebRIM application profiles.

As this is a topic that is not really specific to the geographic community, IT solutions such as ebRIM/ebRS from OASIS and OpenSearch from Amazon are also discussed.

5.1.5. Data Catalogue and Service Vocabularies (Metadata)

5.1.5.1. World Wide Web Consortium (W3C)

5.1.5.1.1. Data Catalogue Vocabulary (DCAT)

World Wide Web Consortium (W3C) has produced a vocabulary specification enabling the interoperability of well understood Data Catalogue terms, this main specification is called “DCAT”. In using DCAT to describe datasets within Data catalogues, publishers increase the discoverability and enable applications to easily consume metadata from multiple data catalogues.

5.1.5.2. European Union (EU)

5.1.5.2.1. INSPIRE (GeoDCAT)

GeoDCAT is an initiative trying to combine the DCAT metadata as they are used in the open data and e-government community with the ISO 19115/57/19 standards and the INSPIRE metadata as they are used in the geospatial community. GeoDCAT has the ability to publish metadata directly on the web without open and geospatial data portals.

GeoDCAT-Application Profile (AP) is a Resource Description Framework (RDF) vocabulary designed to facilitate interoperability between data catalogues published on the Web. GeoDCAT-AP is a European initiative providing an extension of DCAT and its AP for describing geospatial datasets, dataset series, and services. It provides an RDF syntax binding for the union / mapping of metadata elements defined in the core profile of ISO 19115:2003 and those defined in the framework of the

[10] https://docs.opengeospatial.org/is/12-168r6/12-168r6.html

INSPIRE Directive. Its basic use case is to make spatial datasets, data series, and services searchable on general data portals, thereby making geospatial information better searchable across borders and sectors.

As it is becoming a mature technology, OGC Metadata Domain Working Group (DWG) (now called the Metadata and Catalogue DWG) has written a Best Practices paper on the geo extensions of DCAT-AP.

This new form of metadata could be an opportunity for DGIWG to do outreach to the Semantic Web communities.

5.1.6. Register Standards

Registration of information (a register) offers several benefits to a respective community and its information, applications. Registration promotes:

1) Standard description of data. Supports wider use of register item data both by providing international recognition to the fact and by making them publicly available to potential users,
2) Management of the components of data. Provides both immediate recognition to extensions of an International Standard and a source for updates to that standard during the regular maintenance cycle,
3) Common understanding of data across organisational elements and between organisations.

   May provide a single mechanism to access information concerning items that are specified in different standards,
4) Re-use and standardisation of data over time, space and applications. Provides a mechanism for managing temporal change
5) Re-use of the components of data. May be used to make sets of standardised tags available for encoding of registered items,
6) Harmonisation and standardisation of data within an organisation and across organisations. Supports cultural and linguistic adaptability by providing a means for recording equivalent names of items used in different languages, cultures, application areas and professions and a means for making those equivalent names publicly available.

5.1.6.1. ISO 19135-1

This standard describes Procedures for item registration. ISO 19135-1:2015, Geographic information -- Procedures for item registration -- Part 1: Fundamentals revises ISO 19135:2005. It includes description of the management procedures. ISO/TS 19135-2:2012, Geographic information – Procedures for item registration – Part 2 is the XML schema implementation of this ISO standard.

5.1.6.2. ISO/IEC 11179-x

This suite of standards was established jointly by ISO and the International Electrotechnical Commission (IEC). It is not specific to geo yet has cross community relationship potential (using metadata) to enabling understanding and interoperability of data for machines.

ISO 11179, Metadata Registries (MDR) “addresses the semantics of data, the representation of data and the registrations of the description of that data. Generally, descriptive data is known as metadata.” (taken from paragraph 1 and 4 on page v – ISO 11179-1: Framework: 2004) (see section 5.1.7.2)

ISO 11179 is made up of the following parts:

1) Part 1:2015 Framework (this part describes general concepts and how other parts interact with each other).

2) Part 2:2019 Classification (this part focuses on the registration and administration of all or part of a classification scheme) (classification schemes are used within Simple Knowledge Organization System (SKOS))

3) Part 3:2013 Registry metamodel and basic attributes (this part provides for the attributes of data elements and associated metadata to be specified and registered as metadata items in an MDR.)

4) Part 4:2004 Formulation of data definitions (this part provides definitional requirements and recommendations)

5) Part 5:2015 Naming and identification principles (this part provides instruction for naming and identification of data element concept, conceptual domain, data element and value domain.)

6) Part 6:2015 Registration (this part provides the procedure by which an administered item required in various application area could be registered and assigned an internationally unique identifier.)

All those parts describe different components required to set up a metadata register. This suite of standards outlines an ontological schema structure for logical reasoning of multiple schemas, registers and their terminology.

ISO 11179 may have a technical relationship to other widely established vocabularies, e.g. DCAT, SKOS.

5.1.7. Registers and Code Lists

A code list or enumeration is a predefined named list with distinct values from which some coded concepts takes their values.[11] Code lists can be flexibly extended, enumeration cannot.

A register is a controlled set of code lists and enumerations used to harmonise the content of metadata and efficiently manage its schema:

1) ISO 19115 and ISO 19115-1 make use of code lists for some metadata elements to harmonise its content.

   Note: New elements from ISO 19115-1 code lists have been added to DMF only if a need was foreseen and not systematically.

2) Country codes are defined by ISO 3166-x for DGIWG. It is noted that nations or organisations will have different implementations (e.g. STANAG 1059), which may subset or add to ISO 3166.

3) Language codes are defined by:

   a. ISO 639-2 (3-letter codes). ISO 639-2 defined both bibliographic and terminology letter code. Note: STANAG 2586 NATO Geospatial Metadata Profile (NGMP), DGIWG Metadata Foundation and INSPIRE are using the bibliographic form of ISO 639-2.

   b. ISO 639-1 also defined 2-letter codes for languages.

4) The IANA is maintaining a register of character set codes (http://www.iana.org/assignments/character-sets) (e.g. UTF-8).

5) The IETF is maintaining a register of Unique Reference Numbers (URNs), DGIWG has a registered URN. DGIWG needs to assess this to see if this still meets a DGIWG data and metadata requirement. (RFC 6288 - DGIWG namespace)

6) ISO 4217 defines a currency code list (e.g. dollar, euro, etc.).

[11] Based on “OECD Glossary of Statistical Terms – Code list Definition (https://stats.oecd.org/glossary/detail.asp?ID=3371)

7) EPSG Geodetic Parameter Registry (https://www.epsg-registry.org/) and OGC are maintaining units of measures and coordinate reference systems registers. ISO has also developed a register for Geodetic Codes (ISO 19127 – 2019) https://geodetic.isotc211.org/.

It is recognised that each domain of knowledge (e.g. linguistics, mathematics, physics, geospatial, etc.) will each have their own concepts, encoded using their own name spaces or codespaces, managed by other domain specific (e.g. Oil and Gas, Space, etc.) organisations either by nation(s), and multinational parties, e.g. MGCP, IPHG, United Nations. These are outside of DGIWG remit yet will need to be evaluated for interoperability with DGIWG standards.

5.2. Defence

This section highlights an outline of the construction of metadata standards and specifications for the Defence community.

5.2.1. Defence Metadata Specifications

1) **NATO Core Metadata Specification (NCMS)**, published early 2015, replaced the former NATO Discovery Metadata Specification (NDMS). The NCMS Common Layer is primarily based on the elements defined in ISO 15836:2009 as the Dublin Core Metadata Element Set. The NCMS Security Layer provides the metadata elements for capturing information about the classification and releasability of a resource as part of a confidentiality label in accord with STANAG 4774, Confidentiality Metadata Label Syntax. An Information Lifecycle Support Layer contains elements that additionally support information management functions.
   The Joint ISR Community utilized the NCMS/NDMS as de-facto baseline for its Joint ISR Trial Unified Vision 2014 core metadata harmonisation initiative, which developed metadata mappings between various communities of interest metadata models, including the NATO Standard ISR Library Interface (NSILI) Metadata Model, which is used by NATO Coalition Shared Data (CSD) Systems.

   It is of importance that DGIWG Metadata be mapped to the NCMS, to prepare for interoperability with a wider community than just GEO. A limited mapping from DMF to NCMS has already been realised.

   NATO under its Core Data Framework has produced an XML Naming and Design Rules (XNDR) document specifying the XML 2 naming and design rules, guidance, and best practices for use within the NATO Core Data Framework 3 (NCDF).

2) The **STANAG 4559 NATO Standard ISR Library Interface (NSILI)** provides a standard interface and metadata catalogue for querying and accessing distributed ISR product libraries maintained by NATO and NATO Nations. From its very beginnings as standard imagery library interface, STANAG 4559 has expanded the interface and data model for discovery and retrieval of more general ISR data, including distributed repositories of Ground Moving Target Indicator (GMTI) data, Synthetic Aperture Radar (SAR) data, Electro Optical (EO) imagery, Infra-Red (IR) imagery, Motion Imagery (MI), as well as exploitation products, Collection and Exploitation Plans, and others. In its newest edition STANAG 4559 will also support streaming data and Joint ISR workflow artefacts. Today's NSILI Interfaces and Services are the main enablers of NATO's Coalition Shared Data and Joint ISR initiatives.

3) The **Geospatial Maritime Working Group (GMWG)** is responsible for the Additional Military Layers (AML) initiative to add supplementary information to nautical charts. AML also include feature and dataset metadata. It is necessary to ensure by coordinating with this group that DMF and those metadata are consistent.

4) The **Geospatial Aeronautical Working Group (GAWG)** will also consider using NGMP metadata to exchange aeronautical data. It is necessary to ensure by coordinating with this group that DMF and those aeronautical metadata requirements and implementations are consistent.

5.2.2. Defence Profiles of the ISO Metadata Standards

1) **DGIWG 114, DGIWG Metadata Foundation (DMF)** is the DGIWG metadata specification. Version 1.0.1 was published end-2014. It is applicable to all DGIWG datasets, series, products, services and projects. Version 2.0 has been published mid-2017. It includes Sensor elements and an implementation according to generation 2 of ISO metadata standards.

2) **STANAG 2586, NATO Geospatial Metadata Profile (NGMP)**: defined by NATO JGSWG with support of DGIWG, addressing NATO Command Structure requirements. It is also a profile of DMF. NGMP is the metadata standard applicable for NGIF datasets and series. It includes both XML and ESRI Shapefile implementation. A new version has been developed with minor changes (code list updates). The new edition of STANAG 2586 (edition 2) states that DMF 2.0 should be used for NATO needs. This has required the establishment of guideline documents explaining how to use DMF 2.0 within the NATO context, published as SRDs.

3) This metadata specification for TRD 5 is currently being reviewed and revised with DGIWG P3 assistance enabling alignment to DMF.

5.2.3. Example of Military National Metadata Standards/Profiles

1) **Geospatial Metadata (Canada):** The Government of Canada developed a Standard for Geospatial Data that mandates all federal departments to conform to ISO 19115 for Geographic Information Metadata, ISO 19128 for Geographic Information Web Map Server Interface, and the North American Profile (NAP) of ISO 19115:2003 Geographic Information Metadata. The Department of National Defence performed a crosswalk mapping of its metadata against the NATO STANAG 2586, NATO Geospatial Metadata Profile (NGMP), and concluded that CAN is compliant with the standard and uses more mandatory metadata elements than what are identified in the STANAG. Canada will be in a position to comply with STANAG 2586 when it is updated with the DMF in the future.

2) **NMF (U.S. NSG Metadata Foundation[12]):** This metadata profile has been developed by NGA through its Metadata Focus Group. A gap analysis has been conducted between NMF 2.1 and NGMP in the scope of NGIF. The result of this analysis is that NGMP should be used for NGIF metadata (dataset and series level). The NMF has been embedded within the NSG Application Schema (NAS). Note: Minor metadata conceptual changes have been made e.g. Domain and Property metadata

3) **ANZLIC (AUS and NZL Metadata Foundation):** This metadata profile is the peak intergovernmental organisation providing leadership in the collection, management and use of spatial information in Australia and New Zealand.

4) **MGMP (UK MOD Geospatial Metadata Profile):** This metadata profile was developed through JGI Standards Development. The current profile is version 2.0. MGMP is a profile of ISO 19115/19119/19157, its national government metadata profile (GEMINI) and has association to other required military metadata profiles. A mapping has been produced between MGMP and DMF 2.0 allowing DMF metadata to be ingested and supplied at the UK boundary. Version 3.0 aim is to fully instigate DMF current version.

5.2.4. Defence Metadata services

With ever larger, complex structured geospatial data, information and knowledge silos being accessed, via a user enabled server request. The server request uses service metadata to retrieve the data from the server. Supporting metadata services are critical to delivering accurate (with structured, terminological and rule sets), timely and suitable access to geospatial web services.

[12] NMF is part of the US National System for Geospatial Intelligence (NSG)

More information about Catalogue services and project P5.2 CSW is to be found with the DGIWG Web Service Technical panel area on the DGIWG web site (www.dgiwg.org). The current DGIWG CSW profiles an OGC CSW version 2.0.

5.2.5. Defence Metadata registers and code lists

DMF and NGMP both defined a set of code lists for standardised vocabularies. A large part of these code lists come from ISO and most of the remaining ones are NATO specific. NATO specific code lists are seen to be disseminated by NATO, with assistance from requested technical parties.

The NMRR (NATO Metadata Registry and Repository) is controlled and exploited by NCIA. It is a registry tool used to store reference information (XML schemas, documents, etc.) within NATO. It also includes a Vocabulary Register aimed at storing different metadata concepts [4.1.2] and providing tools to facilitate mapping between different concepts.

6. Technology considerations

6.1. Existing

The efficient use of metadata depends on the exchange and encoding format of the metadata. XML based encoding, such as ISO 19139 and 19115-3, enables the use of interoperability tools which allow for schema transformations like XSLT, or quality and conformity checks using XML schemas (XSD) and Schematron (for example, a stand-alone application like XML Spy or a web-based application like INSPIRE geoportal, enable users to check the validity of their metadata according to an agreed standard). XML is also the format used by OGC Web Services.

However, XML syntax is designed for machine to machine communication and not for machine to human communication so it is difficult to read for a human. The development of user-friendly applications is therefore required to facilitate the collection, discovery and viewing of metadata." For example, the existing implementations of catalogue services are GeoNetwork, ESRI metadata editor, which enable the collection of metadata conformant to ISO standards.

Sometimes, instead of developing management tools enabling the exploitation of XML metadata, organisations may choose to use another encoding for their metadata. For example, ESRI Shapefile implementation was required for NGMP by the NATO Command Structure. One of the disadvantages of an ESRI Shapefile implementation is that they flatten the structure of the conceptual metadata model causing multiplicity and domain issues, implying loss of information, no support for XML based transformations and no support for mainstream-IT data validation mechanisms. Further, ESRI Shapefiles do not efficiently support developments as addressed in section 6.2. Recently, within the Coordinating Nation (CN)/Producing Nation (PN) process of NATO, an ESRI Shapefile implementation or an ESRI geodatabase has been proposed for metadata exchange, partly based on NGMP requirements.

6.2. Emerging

6.2.1. Emerging encoding formats

In addition to the formats described in the previous section, some other emerging formats can also be considered to encode metadata. For example, JSON (JavaScript Object Notation) is a format which is more and more common in a web context that could be considered. Semantic Web technologies like DCAT, RDF, Triple stores, SKOS could also be considered for metadata encoding.

6.2.2. Unique Resource Identifiers and Semantic Web

Some other important developments related to metadata are:

1) the use of unique resource identifiers;

2) ISO 19101-12014: Geographic information – Reference model Part 1: fundamentals, with semantic heterogeneity (“the difference of meaning between concepts and data used to represent reality, because of the various perspectives (or contexts) from which real-world phenomena were abstracted.”) with and between schemes, ontologies; and

3) semantic data on the web (or known as Semantic Web) and Linked Data.

These developments are key for an efficient and consistent management of metadata. Moreover, together they provide a mechanism that would significantly enhance semantic interoperability between different information domains. The recommendations of the ISO AdHoc group on metadata management highlight the need for uniquely identifiable metadata elements, using permanent and resolvable identifiers. It also stresses the very important role of registers and organisational embedding of ISO19135-1 for metadata management.

6.2.3. Spatial Data on the Web

The paper “Spatial Data on the Web Best practices”, (28th September 2017), published by W3C, insists on the importance of metadata to make data available on the Web. The group aim was to determine how spatial information can best be published on the Web. Sensors, connected devices and services from different domains are becoming integrated using the web as a common data sharing platform. Also;

1) to determine how machines and people can discover that different facts in different datasets relate to the same place, especially when 'place' is expressed in different ways and at different levels of granularity;

2) to identify and assess existing methods and tools and then create a set of best practices for their use.

Spatial Data on the Web Group has now evolved into the Spatial Data on the Web interest Group, producing Best Practice documents.

6.2.4. Other Types of Geospatial Information and their Uses

6.2.4.1. Building Information Modeling (BIM)

BIM is a 3D building model that allows management of the building. BIM itself is not new but it is used more and more coordinating with geographic information to display a finer level of detail about a geographical feature, “building”. BIM information allows a user to know, its construction materials, what is within a building like rooms, internal walls, wall construction (structural or non-structural, etc. As any data concept it includes metadata and future work might be to consider this metadata and see how they are aligned with geo-metadata.

6.2.4.2. Digital twin

A digital twin is a digital replica of a living or non-living physical entity, where sensors gather data from the physical world to reconstruct it in the digital realm captured only once. A digital twin can offer insights on how to improve operations, increase efficiency or discover issues (e.g. operational troop manoeuvres), all possible before it happens to its real-world twin.

6.2.4.3. Dynamic Metadata

Real time geospatial information processing is an increasing required capability enabling user’s greater insight of information spaces achieving a time dominant requirement. The integration of different sources of data requires strong and precise dynamic metadata.

6.2.4.4. Augmented / Virtual Reality

Augmented and Virtual Reality is a way to represent the data that is more and more in use and that has many applications within Defence from training to in-the-field data visualization. Augmented and Virtual Reality is increasing important within the Defence environment for training and simulation purposes. The integration of different sources of data requires strong and precise metadata.

6.2.5. Research and Development Activities

Research has been carried out by GBR of the DGIWG Metadata Technical panel using wider academic research of geospatial information and concepts that interrelate to geospatial information.

Given today's information systems and structures the following support the realisation of achieving highly interconnected structured, semi and unstructured information (including human knowledge) at pace with;

6.2.5.1. Knowledge Management

Ted Nelson, in his 1974 paper (https://monoskop.org/log/?p=3405), coined a term "Interwingularity" to outline that "there are no subjects at all; there is only all knowledge, since cross-connections among the myriad topics of this world cannot be divided up neatly", expressing the complexity of interrelations in human knowledge.

Knowledge management is the next progression in information science which is a process of creating, sharing, using and managing additional information to enable further insights to be generated from already collected information. Knowledge management involves the following high-level metadata concepts;

1) Structured controlled vocabularies: Hierarchical taxonomy and thesaurus, e.g. NATO Taxonomy, EU (e.g. GeoDCAT), UN vocabularies,
2) Unstructured vocabularies: uncontrolled tagged information terms (e.g. Open street map),
3) Public applied tags: Folksonomy (Social tagging),
4) Domain specific vocabularies with (factual relationships (Axioms) between them) (or statements of fact (Axiom)): Ontologies (see section 7.2.4),
5) Mereology: (Philosophy and mathematical logic) the study of parts and the wholes they form: explored as predicate logic (for the physical thing) and or description logic (for the textual thing) and formal ontology based on a point-free foundation of geometry.

To enable the delivery of knowledge management using metadata, these will, due to the amount of information generated, require automation.

Law for Digital Geographic Information Knowledge Management**:**

Tobler's First Law of Geography

"Everything is related to everything else, but near things are more related than distant things."

(taken from "https://www.geographyrealm.com/toblers-first-law-geography/" and "https://www.researchgate.net/publication/328723512_Tobler's_First_Law_of_Geography")

Albert Einstein

"The grand aim of science is to cover the greatest number of empirical (*observational or experimental*) facts by logical deduction from the smallest number of hypotheses or axioms."

(taken from "The Master Algorithm" by Pedro Domingos, 2015)

Tobler's First Law for the Digital Environment

Tobler's First Law can be updated for the digital age to;

"Everything is related to everything else, by empirical (*observational or experimental*) facts through logical deduction from the smallest number of hypotheses or axioms."

Everything is a group of things the singularly is a "Thing"

A "Thing" is a unit of knowledge be that an object, concept, its property and or a characteristic." (constructed from review of ISO 1087:2019)

Empirical "Thing"

A physical thing within the universe of disclosure will simply have 6 physical faces (a cube) and it would have n-dimensional properties or attributes (including metadata) (vertices), the cube faces morph up to n-dimensional faces / vertices resembling a sphere. Where each face has a (Kinematic or Kinetic) force(s) acting upon it. e.g. gravity, wind (speed), air pressure, etc (e.g. UK Met Office Numerical Weather Prediction (NWP) simulations).

Conceptual "Thing"

A conceptual thing within the universe of disclosure will have a 0-dimensional construct yet will have (kinetic or conceptual) n-dimensional forces acting upon them.

Digital "Thing"

To identify and simulate a "thing" within a digital environment; a "digital twin" of the real-world thing is created enabling multiple hypothetical hypothesis to be carried out, facilitating logical deductions to be formed and or considered with a level of confidence (trust).

Description of the "Thing"

Humans and machines (or human programming the machines) communicate the "Thing" concepts solely, through language whether that is written, verbal, (and even body). A step towards achieving interoperability without contravening computer systems or people's expectations based on their societal backgrounds is through language interoperability or in data terms; semi and unstructured information interoperability with structured information.

Metadata Discovery / Harvesting (or "Metadata Scanning")

Metadata discovery / harvesting is part of the initial process. The process involves automatically reviewing data, or data headers, gathering metadata or data using Extract, Transform & Load (ETL) software to categorise the data into groups (called "classes" or mathematical known as "sets").

The process uses automated tools to discover the semantics of a data element(s) in data sets assigning a suitable category e.g. Topological, Aeronautical or at a finer level; e.g. Transportation, Agricultural. The process usually ends with a set of mappings between the data source elements and a centralised metadata registry. The process allows user interface designers to access a pool of common graphical user interface and report header structured labels.

Semantic Metadata (Semantic Web)

Metadata describes the "meaning" of data. Meaning of data is divided into two applications; first applying to the meaning of data values and second, the meaning of the names of things that can take on such values.

Semantic metadata "https://www.marklogic.com/blog/making-case-semantic-metadata/" involves the following developmental stages;

1) “Semantic matching” (matching operator which identifies those nodes in two graph-like structures (e.g. classifications, taxonomies, XML schemas and ontologies) where semantics correspond to one another) with;
2) “Semantic technology” (making the machine “understand” the data and enable the encoding of semantics with the data (e.g. ISO 11179 possibly with thesauri, classification schemes in W3C SKOS conceptualisation encoded in W3C RDF / OWL) to;
3) “Semantic integration” (interrelate information from diverse sources) using;
4) “Metadata Publishing” (process of making metadata available to users) published or managed of;
5) “Topic Maps” are like a “Knowledge map” or a “Knowledge graph” and otherwise known as “Concept maps”, (is a standard for the representation and interchange of knowledge, with an emphasis on the findability of information.)

The ISO standard is ISO/IEC 13250:2003 or OASIS Darwin/Document Information Typing Architecture (DITA) are the standards.

Services

Application Programming Interface (API)

An application programming interface (API) is a computer interface or communication protocol between a client and a server, its aim is to simplify the building of client-side software.

Open API

Within the Open API (metadata components within this specification is known as “Info Object” and “Tag Object”) other metadata or data is outlined as well, these, at a high level are:

1) openapi,
2) info,
3) servers,
4) path,
5) components,
6) security,
7) tags,
8) externalDocs, these may be extended using Extensions.

OGC API

17-069r1 OGC API – Features – Part 1 Core **(metadata component within this specification is known as “API definition”)**

OpenAPI definitions can be created using different approaches. A typical example is the representation of the feature collections. One approach is to use a path parameter “collectionId”, i.e., the API definition has only a single path entry for all feature collections. Another approach is to explicitly define each feature collection in a separate path and without a path parameter, which allows users to specify filter parameters or explicit feature schemas per feature collection. Both approaches are valid.

7. Metadata standardisation - future state

7.1. Target objectives

To ensure an efficient usage of metadata within DGIWG nations and the DGIF, several constituents are needed in support, is:

1) Metadata specification (DMF),
2) Catalogue Service (CSW) enabling the discovery and evaluation of metadata and
3) A set of registers, and
4) A registry to support management of metadata, their semantic interrelationship and user metadata knowledge.

7.1.1. Short-term vision (2 years)

Concerning DMF, the challenge is now to encourage DMF implementation within the member nations through the development of DMF-specific tools such as metadata editors or validators. Such tools would allow a wider and more operational use of DMF. DMF implementation should also be encouraged as extension of well-known software such as (ESRI, GeoNetwork, etc. preferably XML based on ISO implementation). Implementation of DMF should also encourage the adoption of a DMF namespace within any encoding (yet to start with preferably XML) that can act as an inbuilt metadata validator.

In the meantime, the development and usage of a DGIWG metadata catalogue along with metadata registers and a registry, managed accordingly to DGIWG 915 Register Maintenance Procedure, are crucial both for user and management activities regarding metadata, and proper exploitation of the DGIF infrastructure. This subject is a key point that must be dealt with in a short to mid-term by DGIWG and generational formats used.

7.1.2. Mid-term vision (5 years)

DMF use within nations must continue to be pushed by DGIWG. DMF should also be aligned with other agreed formats (like RDF, JSON) (JSON is the format outlined for Spatial Data on the Web and RDF for Semantic Web). A format review questionnaire will be required ensuring future national operational use is considered.

7.1.3. Long-term vision (10 years)

In the long term, DMF must be truly regarded as the Defence “foundation” of all DGIWG standards for metadata while continuing to adapt to the evolution of technologies (quantum computers[13], blockchain[14], etc.) It is of great importance that the coordination with other Defence Partners (i.e. NATO, MGCP) lead to the emergence of consistent standards among the different communities. It is also an objective to encourage software vendors to enable user-friendly use of the DMF (collecting, conformance testing, validation, editing, etc.) through extensions or specific tools.

[13] Quantum computing is the study of ways in which unusual quantum mechanical effects could be employed to improve the processing power of computers in solving problems. (Definition from Dictionary of Computer Science - Oxford Quick Reference, 2016)

[14] A digital ledger of records arranged into linked chunks of data called blocks, that are associated together through a hashing function that provides cryptographic validation on those records. [http://docs.opengeospatial.org/dp/18-041r1/18-041r1.html]

7.2. Geospatial Metadata content

7.2.1. Feature level Metadata

Metadata has traditionally been worked and applied to dataset and services, however there is a growing need for metadata at the feature and attribute levels in the context of MGCP and DGIF. A feature/attribute level metadata schema harmonised between MGCP and DGIF would enhance interoperability of data content between military organisations.

Feature level and semantic metadata are also areas that will increase with the development and enablement of Web Services combining data from different sources, called data fusion. Each individual data element (object) will need its own metadata, and the resulting dataset should also have an aggregated metadata set. Rules and Axioms will need to be established, first to define the feature level and semantic metadata, then to generate an aggregated metadata set for the dataset.

7.2.2. Product specification Metadata

Even if a general metadata specification is applied, the use of this general metadata specification (DMF) should be specialised for each product. Thus, product specification should not only contain description of the content of the data but also description of the content of the metadata. DGIWG profile of ISO 19131 includes a part called “metadata”. This part should reference the last version of DMF and add recommendations on which elements to be used, with which cardinality, value domains or specific values if applicable. Metadata panel will need to provide help and advices to product specification team to write this metadata part.

7.2.3. DGIWG Product Object concept

The Product Object Specification concept has originally been introduced to fulfil DGIWG Portrayal Catalogue generation requirements. This concept might include in future anything needed to generate a DGIWG data Product Specification, including metadata (see 7.2.2). Coordination work is foreseen to incorporate metadata aspects with this concept.

7.2.4. Ontologies

An ontology uses multiple domain vocabularies currently controlled like thesauri or classification schemes (which do not assert (axioms (which are “facts”)) to be interoperable. It can use a Knowledge Organization Systems (KOS) using linguistics, expressing a domain concept/entity producing a logical set of axioms (facts) about a domain’s universe of disclosure and its interoperability with other domains. KOS enable inferences (or value-added data) to be extracted.

Ontologies are being used to describe geospatial concepts and content e.g. Time, Data quality. This new trend tends to reapportion “traditional metadata”, to domain concepts/entities. This evolution should be followed by DGIWG to assess metadata via its metadata panel, semantic and language interpretation needs within this domain. See Research and Development Activities.

7.2.5. Human Geography

Person or “Entity” (as understood by ISO 11179-3: 2013) metadata will describe human parties operating within a military environment. Human Geography will be taken forward predominantly via the International Program for Human Geography (IPHG). IPHG use metadata aligned with the US NMF structure. This area should be followed by DGIWG metadata panel to assess current and future metadata requirements within the geospatial domain. It is noted that the DGIWG Vector Models and Schema Team (VMST) has formed a sub-team dedicated to Human Geography. The metadata panel should continue to further engage with VMST to address Human geography metadata requirements.

7.3. Geospatial services

DMF is required to enable the efficient usage of the search facility of a catalogue web service.

A registry service, with registers including an associate namespace is also required to be able to publish and maintain DMF metadata fundamentals human to machine and machine to machine.

7.4. Standardisation initiatives

7.4.1. Civil standards

7.4.1.1. ISO TC211 Metadata works

ISO 19139 has been revised to separate the general encoding rules from the XML schema for metadata. The encoding rules are included in a new technical specification ISO 19139-1.

These works about implementation standards (ISO 19139 and 19139-1) are crucial for the implementation of ISO 19115-1 and have to be adopted by DGIWG.

ISO 19115-2:2009 has also been revised, and certain required code lists have been integrated into DMF 2.0.

ISO 19150-1:2012, reviewed and confirmed as valid in 2016. This standard defines the framework for semantic interoperability of geographic information. This framework defines a high-level model of the components required to handle semantic in the ISO geographic information standards with the use of ontologies.

ISO 19150-2:2015/AMD.1:2019 (Rules for developing ontologies in the Web Ontology Language (OWL). This standard defines rules and guidelines for the development of ontologies to support better the interoperability of geographic information over the Semantic Web. OWL is the language adopted for ontologies.

It does not define semantic operators, rules for service ontologies, and does not develop any ontology.

ISO 19150-4:2019: Service Ontology This standard is a framework for geographic information service ontology and the description of geographic information web services in OWL.

ISO 19165 – Preservation of digital data and metadata is another new work item, which is out of the scope for DGIWG.

7.4.1.2. OGC (Continued Metadata Development)

Current OGC Metadata works are mainly related with Catalogue Services (see DGIWG Web Services Technical Panel Roadmap for more details).

The OGC “Geospatial User Feedback” standard[15] aimed to define an extension to ISO 19115-1 and 19157, to enable users to store their feedback on web available data using a catalogue service. The interest for DGIWG and DGIWG nations still must be evaluated.

OGC has also reactivated a domain working group on metadata and catalogues. It is critical to keep this group aware of DGIWG metadata activities.

7.4.2. Defence standards

7.4.2.1. NATO (Continued Metadata Development)

Coordination has been established between the DGIWG Metadata Technical Panel and the JISR.

[15] https://docs.opengeospatial.org/is/15-097r1/15-097r1.html

Future information sharing in NATO (NATO Network Enabled Capability (NNEC), Federated Mission Network (FMN) requires a robust mechanism that will control and guarantee information security, integrity and releasability across federated IT-networks. The fundamental concept of “confidentiality labelling”, as laid down in STANAG 4774 and STANAG 4778, is the realisation of the aforementioned requirement; both DGIWG, JGSWG and NATO JCG-ISR contributed in its development. It is anticipated that “confidentiality labelling” will evolve further, and DGIWG will need to safeguard its DMF standard to keep synchronised with STANAG 4774 and 4778, and other information security specifications within NATO.

Moreover, the STANAG NGMP has been revised. This new edition has been the occasion to consider a compliance with the NATO Confidentiality Metadata Label Syntax.

8. Program plan

8.1. DGIWG Metadata Technical Panel

The DGIWG Metadata Technical Panel coordinates metadata activities within DGIWG and ensures coordination with civilian standardisation bodies and military customers regarding metadata.

Its mission includes the following:

1) To maintain (annual revision) of this document, the DGIWG Metadata Roadmap,
2) To coordinate, contribute to, and support military requirements within the civilian standardisation activities related to geospatial metadata through the DGIWG liaison with ISO/TC 211 and OGC. Currently, the focus is mainly on ISO TC211 projects (ISO 19115-2, 19157-1, 19165-2) and Defence DWG and Metadata and Catalogue DWG in OGC,
3) To coordinate and provide support to DGIWG projects regarding metadata aspects. This coordination is a two-way process:
    a. This roadmap must take advantage of the work of the various DGIWG project teams that are addressing metadata issues; and
    b. The activities in these project teams must also align with this roadmap.
4) To provide support and ensure a coordination regarding standardisation activities undertaken by other sectorial bodies (e.g. IHO, WMO) or other defence organisations (e.g. MGCP, NATO JCGISR IMWG, JGSWG, NMRR, GMWG, GAWG etc.); conducting a gap analysis and creating mapping documents with other profiles/standards in use in the military or civilian community.
5) To determine, manage and revise the requirements for DMF, metadata profiles and metadata registers and revise them,
6) To provide metadata best practices/guidelines for the use by the military community (enabling compatibility and interoperability), along with providing for use metadata friendly generator/validator applications.

8.2. DGIWG Metadata Register

8.2.1. Register maintenance Team

A Metadata Register Maintenance Team (MT02 (Metadata Register Maintenance) has been established within DGIWG to:

1) address the DGIWG requirements for a metadata register (identified in the D20 report (Metadata Profile Registry)) and new requirements expressed by the Metadata Technical Panel. It will be the “control body” to approve and/or reject proposals to the Metadata Registers

2) create and maintain the appropriate metadata registers (structure and design), and if possible, to be compliant with ISO 19135.

The presence of a metadata register is of great importance for an efficient management and usage of DGIWG Metadata. Metadata registers will provide a single source of information/content promoting syntactic/semantic interoperability of metadata elements across geospatial communities. It will also provide a responsive adjudication/deployment of metadata content.

A list of registers has been set up (data format, geographic extent, responsible party, codelists, data quality measures, units of measure (uom), feature catalogue, product specification, keywords, thesaurus, coordinate reference systems, and portrayal catalogue).

The register content can be populated before having a registry tool to access it. Register items can be translated by volunteering nations. MT02 has issued the DGIWG document 915 (Ed. 2017) (note: review 2020) on DGIWG register procedure.

The NATO Metadata Registry and Repository (NMRR) is a technical solution to host the register in a NATO context, especially components used in the NATO Geospatial Metadata Profile. The DGIWG metadata register, accessible via the DGIWG website, will provide the DGIWG metadata components to the DMF profile users e.g. NATO NGMP.

The Maintenance Team has issued the DGIWG document 915 to determine a procedure for managing a metadata register.

8.2.2. Pilot Register (Metadata) (DGIWG)

A DGIWG Register Concept of Operations (CON OPS) will be developed, enabling a proof of concept register to be established, within an, as yet to be, fully agreed DGIWG operating structure (or registry).

This top-level hierarchical register would be formed of sub registers, like the DGIWG metadata register. The DGIWG metadata register will enable all users to validate produced metadata standard(s) via reference to assured managed technical metadata documentation like Schema Dictionaries and Field value code lists. The CON OPS will become the technical specification outlining the register(s) information architecture, and DGIWG's capability to manage register(s) using the agreed DGIWG-915 procedures, through the use of a registry management tool and agreed management information.

8.3. Expressed Defence metadata requirements

Requirements have been expressed to develop a DGIWG Metadata General Guidelines, including best practices. The guidelines will facilitate consistent adoption of DMF by nations. Informal requirements such as the need for a GeoDCAT implementation of the DMF, Metadata Register XML technical specification, encoding formats and semantic web / semantic sensor web should be considered. Another, as yet not formally expressed, requirement is the consideration of automatic collection of metadata, where minimal human field collection is possible and other metadata fields are inferred based on predefined human field value selection, from field collection or other sources.

9. Dependencies

DGIWG Metadata works should consider current and upcoming works regarding metadata within civilian standardisation bodies such as ISO, OGC, IHO, ICAO, WMO, including Open Standards and metadata requirements within the Defence community (MGCP, TREx, IPHG, NATO such as NATO IMWG, NMRR and NATO Core GIS initiative). It is crucial to coordinate with these communities to ensure that DMF is concise and compliant with these initiatives and requirements, and that DMF is considered during these works.

DGIWG capability to host a metadata registry is vital to strengthen metadata use. The DGIWG Namespace extension task (DMF namespace) is critical to develop and maintain the metadata registry.

A long-term solution shall be sought for hosting the general guidelines wiki and namespaces.

DGIWG metadata usage will also be very dependent on having a metadata editor working to comply with DMF and a validation tool which checks that a metadata record is compliant with DMF. Such tools will make implementation easy and help end-users while collecting and understanding the importance of metadata and will also contribute to the quality and hence interoperability of the metadata. Software tools (e.g. ESRI or GeoNetworks) should support DMF metadata, like they did for EU INSPIRE metadata. In this way one could view, collect, edit and validate a DMF compliant metadata by using a software tool.

Feedback on DMF use e.g. what users, who populate metadata, understands values such as the title, identifier, abstract, lineage statement, series etc.) is necessary to be able to ensure an appropriate collection of metadata fields. Guidelines could be written based on these potential feedbacks.

Common work should be realized between the Metadata Technical Panel and the Web Services Technical Panel regarding the establishment of a Catalogue Service for DGIWG Metadata. This work will include testing of the Catalogue Service with DMF metadata that could highlight the potential improvements for DMF.

Coordination with the Vector and Model Schema Team will be required when dealing with Product Objects and Feature Level Metadata (future works).

Annex A
(Informative)

Summary of activities

Standardisation activity			**Action**[16]	**Description**	**Status**
Identifier	Name	Date			
DMF	**Support**				
DMF - Encoding / Validation	DGIWG Metadata Register: The scoping, development, trial and testing of a standard metadata register structure	Beginning of work: 2018	Develop	Establishment of architecture by; the scoping of ISO, OGC registry standards and profiling for Defence	Open
DMF - Documentation	DMF best practices/guidelines: The collection, and agreement of agreed operating procedures in all aspects of DMF.	Beginning of work: mid-2016	Develop	Best practices/guidelines document for the use of DMF and metadata for DGIWG nation	Open
DMF Tools	DMF Editor / Validator: The scoping and development of a DMF editor with validation capabilities using commercial, open source or national generated software.	Beginning of work:	Assess / Develop	DMF tools could include: • DMF editor, validation and transformation tool (e.g. between the 2 ISO generations)	Open

[16] Action is 1) assess, 2) develop, 3) modify, 4) test and evaluate, 5) combat ready, 6) fade, 7) cancel (retire)

Standardisation activity			**Action**[16]	**Description**	**Status**
Identifier	Name	Date			
DGIWG - 915	DGIWG Metadata Register Maintenance Procedure: The implementation of DGIWG – 915 document, within DGIWG nations.	Beginning of work: mid-2018	Use	Procedure document for the maintenance of the DGIWG metadata register	Open
DMF – Pilot Register	Pilot Register: The formation of a metadata pilot register for DMF Core.	Beginning of work: End 2019	Develop	The formation of a pilot metadata register using ISO 19135-2 and ISO 11179-3.	Open
DMF - GeoDCAT	GeoDCAT: The assessment of this data catalogue for reference within the DMF XML header.		Assess	Participate to any international standardisation work on GeoDCAT • Understanding GeoDCAT • Evaluate DMF against GeoDCAT	Foreseen
DMF – CSW profile	DGIWG CSW profile: Supporting Web Service implementation of the CSW XML encoding and associated metadata	Beginning of work: mid-2017	Support	Support for CSW activities. Help to establish a CSW for DMF metadata (DGIWG CSW profile published, without the issues outlined below) Issues: • Tight coupling, • http/https, • Namespace.	Open
DMF – Formats	DMF New/Other encoding formats: a review of emerging encoding formats	Beginning of work: 2019	Assess	Assess utility of new encoding for DMF (CSV, RDF/XML, RDF, Triples, N-Triples, Turtle, Quads, N-Quads JSON-LD, SHACL)	Foreseen
DMF - Feature Level Metadata	Feature Level Metadata: The review of DMF to establish a metadata profile for features.		Assess	Coordination task for feature level metadata between MGCP TRD4 and DGIF/NGIF model.	Foreseen
DMF – National states	DMF implementation state of play: An understanding of DGIWG Nations implementation of DMF state.	Beginning of work: 2020	Assess	Poll DGIWG nations to understand where they are with their metadata implementations	Foreseen
DMF – Future	Trend analysis: An assessment of trend analysis techniques for metadata and data collection		Assess	Assess the future trends likely to impact DMF: • GeoPackage GPKG metadata	Foreseen

Standardisation activity			**Action**[16]	**Description**	**Status**
Identifier	Name	Date			
NATO	**Support**				
NATO – NGMP / NMF	Support – due to changes: A review of the differences between NGMP and NMF for NGMP collection.	Planned end date: end-2016	Develop	Gap analysis between NGMP and NMF in the scope of NGIF.	Open
NATO - ADatP 4774	Confidentiality Metadata Label Syntax: An assessment of this ADatP with a view to aligning DMF	SD review planned for end 2016	Assess	Provide comments to NATO, and use it to develop a mapping with the NATO Geospatial Metadata Profile and DMF 2.0	Open
NATO - ADatP 4778	Metadata Binding Mechanism for Information Sharing: An assessment of this ADatP with a view to aligning DMF	2017	Assess	Provide comments to NATO in relation with the WSTP.	Open
NATO – NGMP additions	NGMP Maintenance: A modification of STANAG 2586 enabling changes to take effect.		Modify	Address the needs for NGMP additions (mapping with STANAG 7123, shape file format)	Foreseen
NATO – NGMP Validation	NATO Metadata Registry and Repository: An assessment of this NATO repository, STANAG 2586 additions and required support.	Planned end date: 2018	Assess	Study opportunities to store the register in the NMRR	Open
NATO - NIIA	NIIA: NATO Intelligence, Surveillance and Reconnaissance (ISR) Interoperability Architecture: Vol 2: An assessment of this document ensuring any impacts to DMF are mitigated.		Assess	Review NIIA Vol 2	Foreseen
NATO – XML naming and binding rules	NATO XML naming and binding rules: A review of this document to understand if anything impacts DMF.		Assess	Review of NATO XML naming and binding rules	Foreseen

Standardisation activity			Action[16]	Description	Status
Identifier	Name	Date			
ISO	**Support**				
ISO 19115-2	Metadata for imagery: An assessment of ISO 19115-2 ensuring suitable metadata fields are integrated within DMF.	Integrated in DMF 2.0	Assess	Use as an input for DMF 2.0. Anticipate that DMF 2.0 could be used as inputs for the revision of ISO 19115-2.	Open
ISO / OGC – Metadata developments	New ISO standards: A review of ISO and OGC standard development, including working groups for Metadata interest.	No planned end date: an ongoing activity	Assess	Evaluate new ISO standards to see if there is an interest in metadata in DGIWG.	Foreseen
Academia / Industry					
Academia - Metadata Developments	Monitor Academic developments in Metadata	No planned end date: an ongoing activity	Assess		Open
Industry – Metadata developments	Monitor Industry developments in Metadata	No planned end date: an ongoing activity	Assess		Open

Annex B
(Informative)

Summary of DMF implementation of ISO standards