"Delivering Military Advantage through multi-national geospatial interoperability"

DGIWG 906
Metadata Roadmap

Edition 3.0

Date 24 April 2023

Document Type: ENT

Publication Date: 24 April 2023

Edition: 3.0

Edition Date: 19 April 2023

Document status: DGIWG Publication

Responsible Party: DGIWG

Audience: This document is approved for public release and is available on the DGIWG website, http://www.dgiwg.org/dgiwg/

Abstract: This document summarises the development and maintenance activities that the DGIWG P3 Metadata Technical Panel will be undertaking in the next 24 months as well as a technical assessment of emerging trends and concepts that are relevant to the Defence Geospatial community.

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Executive Summary

This document describes the aims and objectives of the DGIWG Metadata Technical Panel (P3) outlining its current and planned activities and deliverables within the short, medium and long term time frames.

The document complements the DGIWG Geospatial Reference Architecture and other DGIWG Panel Roadmaps in supporting the DGIWG Program of Work.

The document is reviewed and updated annually to ensure currency.

ii. Contributing participants

Nation	Parent Organisation
AUT	Federal Ministry of Defence
AUS	Australian Geospatial- Intelligence Organisation (AGO)
DNK	The Danish Agency for Data Supply and Efficiency (SDFE)
FRA	Institut National de L'Information Géographique et Forestière (IGN)
NLD	Defence Geographic Agency (DGA)
GBR	Joint Geospatial Intelligence (JGI)

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iv. Revision history

Date	Edition	Primary clauses modified	Description
Apr 2022	3.0 (WD1)	Whole document	Original Document
Nov2022	3.0 (WD2)	Whole document	Document sent to P0 Quality Panel
Apr 2023	3.0 (FD)	Whole document	Document review completed by P0 Quality Panel
Apr 2023	3.0 (DP)	DGIWG Publication. All Clauses. Final draft revised and harmonized. P0 Quality Control completed	Edition 3.0 replaces edition. 2.3.0 published in 2020

1 Introduction

1.1 The purpose of the Metadata Panel (P3) is to improve the discovery, evaluation, use and management of geospatial information and services within and among DGIWG nations and associates through the development of common metadata standards. While the standardization of the form and meaning of metadata is critical for the efficiency in retrieving relevant and accurate information, the diversity of geospatial information and user requirements needs to be addressed.

1.2 Organizations providing geospatial information must enable its discovery, evaluation, and use. In today's digital 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.

1.3 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 organization'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. standardized lists of terms, such as abbreviations for countries or code lists for categories) and standardized formats for values (e.g. for dates or geographic extents) can greatly improve the efficiency of discovery, evaluation and ultimately knowledge about the information.

1.4 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.

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[1] The Multinational Geospatial Co-production Program (MGCP) was created in April 2003 and currently has 35 participating members. The aim of the program is to collect geospatial data worldwide, concentrating on areas where little data currently exists. MGCP Data is collected in 1 by 1 degree cells of geographic coordinates at scales 1:50,000 and 1:100,000. MGCP have also initiated an Urban Vector Data capture programme (MUVD). The International Program for Human Geography (IPHG) Is a co-production agreement between 12 member countries for the sharing of human geography data.

[2] The Multinational Geospatial Co-production Program (MGCP) was created in April 2003 and currently has 35 participating members. The aim of the program is to collect geospatial data worldwide, concentrating on areas where little data currently exists. MGCP Data is collected in 1 by 1 degree cells of geographic coordinates at scales 1:50,000 and 1:100,000. MGCP have also initiated an Urban Vector Data capture programme (MUVD). The International Program for Human Geography (IPHG) Is a co-production agreement between 12 member countries for the sharing of human geography data.

1.5 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 Geospatial community will increasingly require a standardised metadata terminology and an ability to capture, manage and reuse metadata concepts (e.g. code lists, metadata elements). They will increasingly require to be able to be interoperable with semi and unstructured metadata terminological structures. To address this need, this community will leverage and use, to the largest degree practical, geographic standards from the ISO 19XXX portfolio.

2 Scope

2.1 The P3 Metadata Roadmap serves as both a strategy and planning tool for the DGIWG, the summarizes the planned development and maintenance activities that the DGIWG P3 team will be undertaking in the next 24 months as well a technical assessment of emerging trends and concepts that are relevant to the Defence Geospatial Community. The technical assessments provide DGIWG a brief understanding and view of:

- What the trends are and how they work
- The trends potential benefit to the Defence Geospatial Community
- The trends potential effect on the DGIWG Geospatial Reference Architecture (DGRA)
- An indication of the trend level of maturity level of maturity i.e. is it just emerging or is mature enough to warrant further consideration and development by DGIWG.

2.2 The technical assessment takes both a medium (3-5 year) and long term (6-10 year) view of the trends, their development and potential impact on the Defence Geospatial Community. This document has the following key sections:

- **Target Architecture:** Description of what 'good' looks like both now ('as is') and over the coming years ('should be').
- **Current Responsibilities:** Summarising P3's maintenance responsibilities for existing DGIWG documents.
- **Current and Planned Activities**: Summary of P3's planned technical work for the next 24 months.
- **Emerging Concepts and Associate Standards**: An assessment of emerging technical trends and their potential benefit to the Defence Geospatial Community.

3 References

3.1 DGIWG Documents

3.1 DGIWG 933, DGIWG Geospatial Reference Architecture (DGRA), 2022

3.2 DGIWG Requirements Tracker, 2022

3.3 DGIWG 902, Program of Work (PoW), 2022

3.4 DGIWG 930, Business Manual, 2022

3.5 DGIWG 904, Defence Geospatial Standards Baseline (DGSB)

3.2 International Organization for Standardization (ISO) references

3.2.1 ISO 19115:2003, Geographic information - Metadata

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

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

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

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

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

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

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

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

3.3 Open Geospatial Consortium (OGC) references

3.3.1 OGC 07-045, OGC Catalogue Services Specification 2.0.2 - ISO Metadata Application Profile v1.0 (2007)

4 Terms and abbreviations

Table 1: List of abbreviations and acronyms

Acronym	Definition
API	Application Programming Interface
BIM	Building Information Modeling
CSW (= CS-W)	Catalogue Service for the Web
DCAT	Data Catalogue Vocabulary
DGIF	Defence Geospatial Information Framework
DGIWG	Defence Geospatial Information Working Group
DGRA	DGIWG Geospatial Reference Architecture
DMF	DGIWG Metadata Foundation
GISMO	Geospatial Information to Support Decision Making in Operations
ISO	International Organisation for Standardisation
JSON	Java Script Object Notation
KOS	Knowledge Organisation Systems
MGCP	Multinational Geospatial Co-production Program
OGC	Open Geospatial Consortium
OWL	Web Object Language
RDF	Resource Description Framework
SKOS	Simple Knowledge Organisation System
STANAG	Standardisation Agreement
UML	Unified Modelling Language
XML	eXtensible Mark-up Language

5 Target Vision

5.1 Continuous target

5.1.1 To ensure an efficient usage of metadata within the DGIWG nations and DGIF domain, several constituents are needed:

- Metadata specification (DMF);
- Catalogue Service or API enabling the discovery and evaluation of metadata;
- A set of registers, and a system to support management of metadata, their semantic interrelationship and user metadata knowledge; and
- Guidelines to help with DMF implementation.

5.2 Short Term Vision (2 years)

5.2.1 Current focus is to encourage DMF implementation by member nations through the development of DMF-specific tools such as metadata editors or validators. The tools would assist a wider implementation and operational use of DMF. DMF implementation should also be encouraged by extension in well-known software applications e.g. ESRI, GeoNetwork, etc. (preferably XML based on ISO 19115-3 and 19139 implementation). Implementation of DMF should encourage the adoption of a DMF namespace within any encoding (yet to start with preferably XML) that can act as an inbuilt metadata validator.

5.2.2 A guideline for DMF implementation to assist nations adoption DMF and also at the product specification level to encourage DMF adoption by nations. Guidelines are being developed to assist with product specification integration. This would allow metadata automation, satisfying the Defense Geospatial Community user's need.

5.2.3 The development and usage of a DGIWG metadata catalogue along with metadata registers and a register system, 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.

5.3 Mid Term Vision (5 years)

5.3.1 DMF use within nations and various projects must continue to be pushed by DGIWG. DMF should also be aligned with other agreed formats (like JSON, RDF) (JSON is the format outlined for Spatial Data on the Web and RDF for Semantic Web). The choice of formats will be driven by new APIs or the general technological development.

5.4 Long Term Vision (10 years)

5.4.1 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 (e.g. quantum computers, blockchain, etc.) It is of great importance that the coordination with other Defence Partners (e.g. NATO, MGCP, GISMO) leads 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.

6 Current Responsibilities

6.1 The Metadata Panel is responsible for the maintenance and update of a number of DGIWG's standards profiles and documents. A full list of these and their update date can be found in Annex A of this document.

7 Current and Planned Activities[3]

This Section of the document contains a summary of the technical work being undertaken by the P2 Metadata Panel.

7.1 Maintenance Work

This part contains a summary of the DGIWG documents that P3 will maintain in the next 24 months.

Table 2 Maintenance Activities

Doc ID	Name	Task summary	Document type	Due Date
114	DGIWG Metadata Foundation	P3 to review and update when appropriate	Standard Profile	2023-12
906	DGIWG Metadata Roadmap	P3 to review and update when appropriate	Roadmap	2022-06

7.2 Development Work

This part contains a summary of the technical development work that P3 will be undertaking in the next 24 months.

Table 3 Development activities

Req. No.	Task Name	Task summary	Customer	Output	Due Date
-	DMF Implementation Guidelines	Give guidance to demonstrate how to use DMF for most common metadata use cases. (DMF cookbook).	MN	User Guide	2022-12

8 Emerging Concepts and Associate Standards

8.1 Medium Term Assessment

The key trends identified by P3 which are in scope of its responsibilities, more mature, and therefore likely to affect the Defence Geospatial Community and require further work by DGIWG in the next 3-5 years are as follows:

[3] Content of the tables in section have been extracted from the DGIWG POW

8.1.1 Definite Trend 1: Other levels of Metadata

- **Description:** 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 harmonized between MGCP and DGIF would enhance interoperability of data content among military organisations. This need could also include other metadata levels such as tiles or other kind of subsets.
- **Benefits:** Feature level 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 (feature) 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 metadata, then to generate an aggregated metadata set for the dataset.
- **Relevance to the Geospatial Defence Community:** Feature level metadata have been used for long in Geospatial Community without being called as such. ISO 19115 suite of metadata standards should be able to handle metadata at both feature and attribute level.
- **Level of Maturity:** Feature level metadata work has already started in coordination with vector panel.

8.1.2 Definite Trend 2: Human Geography

- **Description:** 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 panel has formed a sub-team dedicated to Human Geography. The metadata panel should continue to further engage with this team to address Human geography metadata requirements.
- **Benefits:** Harmonizing metadata would allow using the same catalog system, and, beyond, the same information system.
- **Relevance to the Geospatial Defence Community:** Merging human geography technologies/standards with geospatial technologies /standards would increase interoperability.
- **Level of Maturity:** Mature. Work started on this topic under vector panel.

8.1.3 Definite Trend 3: Point Cloud data

- **Description:** With the development of LIDAR technologies for data acquisition by aerial or terrestrial means, many formats and software solutions have emerged to store and exchange that kind of data and various usages already exists like, among others: elevation data production, 3D urban city representation or virtual reality immersion.

- **Benefits:** Describing Point Cloud data with standardized Defence Geospatial metadata will allow integration of those data into systems.
- **Relevance to the Geospatial Defence Community:** Standardization for point cloud is beginning with competing formats such as “LAS” becoming a de-facto standard and being adopted as community standard by OGC, HDF5 possible implementations, SIPC (Sensor Independent Point Cloud) specification developed by US NGA, etc. Recommendations or application profiles for point cloud data exchange by the defence community should become necessary.
- Furthermore, point cloud dissemination is not directly handled by well-known OGC web services standards while solutions arise to optimize access to point cloud data by chunking or tiling strategies such as COPC (Cloud Optimized Point Cloud) or EPT (Entwine Point Tile).
- Point cloud description by Metadata should, of course, be handled to have a consistent integration into the DGRA.
- **Level of Maturity:** This is a relative mature trend as Point Cloud data are already massively produced and it should be considered for adoption by the defence community.

8.1.4 Definite Trend 4: Other Metadata Encoding Formats

- **Description:** Currently, metadata is encoded in XML. However, 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.
- **Benefits:** Integrate formats from the non-geo communities and be able to use non-geo tools. Those formats will also probably be implemented in future softwares and defense systems.
- **Relevance to the Geospatial Defence Community:** Those formats are already used within web services (JSON) or for data encoding. Using those formats for metadata would harmonize the formats used for data/services and metadata.
- **Level of Maturity:** Those formats are all mature in their developing communities and are starting to be used in the geo community.

8.1.5 Definite Trend 5: Spatial data on the Web

- **Description:** The paper “Spatial Data on the Web Best practices”, (published 28th September 2017, last updated September 2022), published by W3C, insists on the importance of metadata to make data available on the Web. The group’s aim was to determine how spatial information can best be published on the Web. The following are also to be considered:
    - 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;

    - 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.
- **Benefits:** Making the data discoverable is a priority to fulfill FAIR principle (Findable Accessible Interoperable Reusable).
- **Relevance to the Geospatial Defence Community:** Being able to easily share data within nations and commands is applicable both in closed and open networks.
- **Level of Maturity:** Those recommendations are already widely adopted in open catalogs.

8.2 Long Term Assessment

The key trends identified by the P3 which are in scope of its responsibilities, less mature, and therefore unlikely to affect the Defence Geospatial Community in the near term and would likely require on further work by DGIWG in the next 6-10 years are as follows:

8.2.1 **Emerging Trend 1: Ontology**

- **Description:** 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 Organisation 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.
- **Benefits:** There numerous benefits form utilising ontologies but the main one is the ability to link and reutilize information inside and outside the geospatial community.
- **Relevance to the Geospatial Defence Community:** Using ontologies would increase the interoperability between defence and civilian communities but also within the Defence Geospatial community.
- **Level of Maturity:** Not fully mature. Dependent on implementations by other communities.

8.2.2 **Emerging Trend 3: Other Types of Geospatial Information**

- **Description:** Other types of Geospatial Information could include:
- 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.

- 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.
- 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.
- 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.
- Perspective imagery**:** With the introduction of augmented reality data into virtual reality activities (simulation, training, scenario analysis, etc.) Stereo (or 3D) imagery and DSMs, such as Textured TINs or Textured meshes to represent terrain or urban scenes, is foreseen to become more relevant in the future.
- Motion imagery: The dramatic spreading during the last years of video recording devices, together with the development of satellite video capture, as well as the number of UAVs with these capabilities make this a relevant trend. This topic may include Motion Imagery according to STANAG 4609 or Full Motion Video (high-fidelity digitally encoded video). OGC Testbed-16: Full Motion Video to Moving Features Engineering Report (available at https://docs.ogc.org/per/20-036.html) provides some recommendations of interest for the usage of STA, Moving Feature Sensors, SensorML, O&M, for Motion imagery or Video Moving Target Indicators, as well as Web Video Map Tracks (WebVMT) that is an open web format based on JavaScript Object Notation (JSON) and W3C Web Video Text Tracks (WebVTT).
- **Relevance to the Geospatial Defence Community:** Those new technologies are starting to be used in the Defence Geospatial Community.Standardising metadata could reduce the gap between simulation and geospatial community.
- **Level of Maturity:** Depending in the Geospatial Information Type, some informations are already standardized (eg BIM in ISO) and used.

Annex A. Artefacts for which P3 is responsible

Table A1 contains a list of completed DGIWG documents and artefacts that the P3 is responsible for maintaining. (Note this table is extracted from the DGIWG PoW and should not be updated in isolation)

Table A1: Artefacts for which metadata panel is responsible

Doc No.	Document Title	Published Date	Edition Date	Review Cycle	Review by date
114	DGIWG Metatadata Foundation	P3	01/09/2017	12/07/2017	3 years
114 SD1	DGIWG Metadata Foundation - XML schemas	P3	02/01/2018	12/07/2017	3 years
906	DGIWG Metadata Roadmap	P3	31/07/2020	2020-07-06 (v.2.3)	3 years

Annex B. Metadata Architecture

A metadata architecture is being defined and will be part of the next version of the roadmap.