"Delivering Military Advantage through multi-national geospatial interoperability"

DGIWG 907

Imagery & Gridded Data Roadmap

Edition: 5.1

Date 14 May 2025

Document Type:	ENT
Publication Date:	14 May 2025
Edition:	5.1
Edition Date:	14 May 2025
Document status:	DGIWG Publication
Responsible Party:	DGIWG
Audience:	This document is approved for public release and is available on the DGIWG website, https://www.dgiwg.org/
Abstract:	The Imagery & Gridded Data (P2) Roadmap summarises the development and maintenance activities that the DGIWG P2 Imagery and Gridded Technical Panel 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.
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ii. Executive Summary

This document describes the aims and objectives of the DGIWG Imagery & Gridded Data Technical Panel (P2) 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.

iii. Contributing participants

Nation	Parent Organisation
FRA	Direction Générale de l'Armement (DGA)
ESP	Cartographic Coordination Department
SWE	Military Geographic Service
USA	National Geospatial-Intelligence Agency (NGA)
TUR	General Command of Mapping
AUS	Australia - Defence
RSA	South Africa Defence
GER	Bundeswehr Geoinformation Service
GBR	UK MoD – Defence Science and Technology Laboratory

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v. Revision history

Date	Edition	Primary clauses modified	Description
26 April 2022	5.0 (WD1)	Original Document	Creation (on basis of previous IGD roadmap version 4.6 May 2021 and new roadmap Template)
01 August 2022	5.0 (WD2)	3. References 4. Terms and abbreviations 5. Target Vision 7.2 Development Work 8.2. Long Term Assessment	Integration of P2 review in May 2022 References and terms and abbreviations alignment with actual content of the document Addition of "5.1 target objectives" and "5.2. IGD Standards assessment" sub-clauses. GeoPackage work addition (7.2) Level of maturity consideration change for long term assessment trends (8.2).

Date	Edition	Primary clauses modified	Description
22 Sept. 2022	5.0 (WD3)	3. References 4. Terms and abbreviations Table 2 - Maintenance Activities 8. Emerging Concepts and Associate Standards	Integration of P2 review in September 2022 - Editorial changes - Reduction of planned maintenance activities
10 Oct. 2022	5.0 (WD3)	7.2 Development Work All clauses	DGED work addition Document marking and style guide application
20 Mar. 2023	5.0 (FD)	Executive Summary Table 3	Modifications after P0 Review Requirement number addition for GeoPackage extension work
Apr 2023	5.0 (DP)	DGIWG Publication. All Clauses. Final draft revised and harmonized. P0 Quality Control completed	Edition 5.0 replaces edition 4.5 published in Oct 202
13 June 2023	WD	3. References 7.1. Maintenance work 7.2. Development work 8.1. Medium term assessment 8.2. Long term assessment	Initiating 5.1 Edition - Update of references - Updates of maintenance and development works - Updates of medium-term and long-term assessment clauses (Geo AI long term trend addition)
14 May 2025	5.1 (FD)	3. References 7.1. Maintenance work 7.2. Development work 8.1. Medium term assessment 8.2. Long term assessment	Final Draft for 5.1 Edition: - Update of references - Updates of maintenance and development works (DGED 1.3, GeoTIFF and ESM GeoPackage) - Updates of medium-term and long-term assessment clauses (HEIF long-term trend addition and 3D Imagery becoming a medium-term trend)

1   Introduction[1]

1.1   The purpose of the Imagery and Gridded Data Panel (P2) is to develop and maintain standards and product specifications for various types of georeferenced imagery and gridded data (IGD) products. This is to facilitate modelling, encoding and access or exchange of georeferenced imagery and gridded data (including coverage and geolocated sensor data), with the aim to increase interoperability across the civil and defence user communities, including imagery intelligence, surveillance and reconnaissance (ISR) and improve production of imagery and terrain products.

1.2   The beneficiaries of IGD P2 activities include DGIWG member nations and associates, as well as defence partners and wider government agencies with ISR capabilities and producers of derived imagery and terrain products.

2   Scope[2]

2.1   The Imagery & Gridded Data (P2) Roadmap summarises the development and maintenance activities that the DGIWG P2 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 assessment provides DGIWG a brief understanding and view of:

- What the trends are and how they work
- Potential' trend benefits to the Defence Geospatial community
- Potential trend effects on the DGRA
- An indication of the maturity level of the trends 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.

2.3   This document has the following key sections:

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[1] The text comes from DGIWG 930 Business Manual Paragraph 6.2 and the respective Purpose clauses.

[2] The text comes from DGIWG 930 Business Manual Paragraph 6.2 and the respective Scope clauses.

- **Target Vision:** Description of how? 'good' looks like, both now ('as is') and over the coming years ('should be').

- **Current Responsibilities:** Summarising P2's maintenance responsibilities for existing DGIWG documents.

- **Current and Planned Activities**: Summary of P2's planned technical work for the next 24 months.

- **Emerging Concepts and Associated Standards**: An assessment of emerging technical trends and their potential benefit to the Defence Geospatial community.

3   References

3.1   DGIWG Documents

3.1.1   DGIWG 933, DGIWG Geospatial Reference Architecture (DGRA), 2023

3.1.2   DGIWG Requirements Tracker, 2022

3.1.3   DGIWG 902, Program of Work (PoW), 2025

3.1.4   DGIWG 930, Business Manual Edition 2.0, 2024

3.2   DGIWG Standards

3.2.1   DGIWG 104(2), Profile of JPEG 2000 for Georeferenced and Referenceable Imagery (v2.1.3)

3.2.2   DGIWG 108, GeoTIFF Profile for Georeferenced Imagery (v2.3.1)

3.2.3   DGIWG 116-1, Elevation Surface Model (ESM) Standardized Profile (v1.1.1)

3.2.4   DGIWG 116-2, Elevation Surface Model (ESM) - GML Application Schema (v1.0.2)

3.2.5   DGIWG 116-3-1, Elevation Surface Model (ESM) - Encoding Rules - Part 1: Core (v1.1.1)

3.2.6   DGIWG 116-3-2, Elevation Surface Model (ESM) - Encoding Rules - Part 2: GeoTIFF (v1.1.1)

3.2.7   DGIWG 116-3-3, Elevation Surface Model (ESM) - Encoding Rules - Part 3: GMLJP2 (v1.1.1)

3.2.8   DGIWG 116-3-4, Elevation Surface Model (ESM) - Encoding Rules - Part 4: NATO Secondary Image Format (NSIF) (v1.1.1)

3.2.9   DGIWG 126, DGIWG GeoPackage Profile 1.3.1 (v 1.0)

3.2.10   DGIWG 250, Defence Gridded Elevation Data (DGED) Product Implementation Profile (v1.2.1)

3.2.11   DGIWG 254, Defence Raster Product (DRP) Implementation Profile (v1.0)

3.2.12   DGIWG 255, Defence Orthoimagery Product (DOP) Implementation Profile (v1.0)

3.3   International Organization for Standardization (ISO) references

3.3.1   ISO 19123-1:2023, Geographic information - Schema for coverage geometry and functions - Part 1: Fundamentals

3.3.2   ISO 19123-2:2018, Geographic information - Schema for coverage geometry and functions - Part 2: Coverage implementation schema

3.3.3   ISO/IEC 12087-5:1998, Image Processing and Interchange (IPI) - Functional specification - Part 5: Basic Image Interchange Format (BIIF) + Corrigenda 1 (2001) and 2 (2002)

3.3.4   ISO/IEC 15444-15:2019, Information technology - JPEG 2000 image coding system - Part 15: High-Throughput JPEG 2000

3.3.5   ISO/IEC BIIF Profile JBP-2021.2 - Joint BIIF Profile 2021.2 (JBP-2021.2)

3.4   Open Geospatial Consortium (OGC) references

3.4.1   OGC 19-008r4, OGC GeoTIFF Standard v1.1 (2019)

3.4.2   OGC 05-047r3, GML in JPEG 2000 for Geographic Imagery (GMLJP2) Encoding Specification v1.0 (2006)

3.4.3   OGC 08-085r8, GML in JPEG 2000 (GMLJP2) Encoding Standard v2.1 (2018)

3.4.4   OGC 09-110r4, WCS 2.0 Interface Standard - Core: Corrigendum v.2.0.1 (2012)

3.4.5   OGC 09-146r2, Coverage Implementation Schema v1.0.1 (2012) renamed from OGC GML Application Schema - Coverages

3.4.6   OGC 07-000, Sensor Model Language (SensorML) Implementation Specification v1.0.0 (2007)

3.4.7   OGC 12-000, SensorML: Model and XML Encoding Standard v2.0 (2014)

3.4.8   OGC 12-000r2, SensorML: Model and XML Encoding Standard v2.1 (2020)

3.4.9   OGC 12-128r18, GeoPackage Encoding Standard v1.3.1 (2021)

3.4.10   OGC 17-066r2, OGC GeoPackage Extension for Tiled Gridded Coverage Data v1.1 (2022)

3.4.11   OGC 17-030r1, LAS Specification OGC Community Standard v1.4 (2018)

3.4.12   OGC 22-025r4, 3D Tiles Specification v1.1 (2023)

3.4.13   OGC 15-078r6, OGC SensorThings API Part 1: Sensing v.1.0 (2016)

3.4.14   OGC 17-014r9, OGC Indexed 3d Scene Layer (I3S) and Scene Layer Package (*.slpk) Format Community Standard v1.3 (2023)

3.5   North Atlantic Treaty Organization (NATO) references

3.5.1   STANAG 4545 Ed: 3, NATO Secondary Imagery Format (NSIF) (2024)

3.5.2   STANAG 4545 Ed: 2, NATO Secondary Imagery Format (NSIF) (2013)

3.5.3   EDP-04 Ed:2 ver.1, NATO Secondary Imagery Format (NSIF) STANAG 4545 (Edition 2) Implementation Guide (2013)

3.5.4   STANAG 4609 Ed: 5, NATO Digital Motion Imagery Standard - MISP-2019.1 (2020)

3.5.5   MISP-2019.1, US Motion Imagery Standards Board (MISB) - Motion Imagery Standards Profile-2019.1 (2018)

3.6   De facto standard references

3.6.1   TIFF format specification Aldus/Adobe. Final revision 6.0 3/06/1992

3.7   National

3.7.1   NGA.STND.0054-1, Sensor Independent Point Cloud (SIPC) Volume 1, Design and Implementation Description Document (DIDD), v1.02 2015

3.7.2   NGA.STND.0054-2, Sensor Independent Point Cloud (SIPC) Volume 2, File Format Description Document (FFDD), v1.02 2015

4 Terms and abbreviations

Acronym	Definition
ASPRS	American Society for Photogrammetry and Remote Sensing
BGIC	Bundeswehr Geoinformation Centre
BIIF	Basic Image Interchange Format
CIS	Coverage Information Schema
COG	Cloud Optimized GeoTIFF
COPC	Cloud Optimized Point Cloud
DGED	Defence Gridded Elevation Data
DRP	Defence Raster Product
DGIF	Defence Geospatial Information Framework
DGIWG	Defence Geospatial Information Working Group
DSM	Digital Surface Model
EPT	Entwine Point Tile
ESM	Elevation Surface Model
GEOINT	Geospatial Intelligence
GIMI	GEOINT Imagery Media for ISR
GML	Geography Markup Language
GMLJP2	GML in JPEG 2000
GWG	Geospatial Intelligence Standards Working Group
HDF	Hierarchical Data Format
HEIF	High Efficiency Image File Format
HTJ2K	High-Throughput JPEG 2000
IGD	Imagery and Gridded Data
IHO	International Hydrographic Organization
IMINT	IMagery INTelligence
ISO	International Organization for Standardization
ISR	Intelligence, Surveillance and Reconnaissance
JPEG	Joint Photographic Experts Group

Acronym	Definition
JPIP	JPEG 2000 Interactive Protocol
Kakadu	Software suite developed by NewSouth Innovations Ltd.
LiDAR	Light Detection And Ranging
netCDF	Network Common Data Form
NGIF	NATO Geospatial Information Framework
NSIF	NATO Secondary Imagery Format
OGC	Open Geospatial Consortium
SIPC	Sensor Independent Point Cloud
STANAG	Standardization Agreement
SWE	Sensor Web Enablement
TC	Technical Committee
TIFF	Tagged Image File Format
TIN	Triangulated Irregular Network
TS	Technical Specification
UAV	Unmanned Aerial Vehicles
WCS	Web Coverage Service
XML	Extensible Markup Language

Table 1 - List of abbreviations and acronyms

5 Target Vision

5.1 Continuous target

5.1.1 Imagery and gridded data are key geospatial information that is produced by Defence agencies and used by military forces in order to provide an accurate view of a given territory at the acquisition date, for Situational Awareness, Mission Planning and in support of Geo Intelligence (GEOINT), Imagery Intelligence (IMINT), and targeting. It is also commonly used as base layer information in geospatial viewers or any geospatial information system and for military command and control systems.

5.1.2 As a continuous target, the imagery standardization coordinated DGIWG effort aims at:

- receiving, analysing and processing DGIWG customers' requirements with the resources it has and may mobilize;

- maintaining the existing DGIWG standards aligned with the evolution of the underlying technologies and civilian standards on which they are relying;

- coordinating with national (e.g. Geospatial Intelligence Standards Working Group (GWG), NATO, International Hydrographic Organization (IHO), OGC and ISO TC 211 initiatives related to geospatial imagery in order to support military requirements within the civilian (among others) standardisation activities;

- providing support information to ease implementations and endorsements of standards by defence organizations of DGIWG member nations, industry or DGIWG customers;

- coordinating with other DGIWG panels and global architecture where imagery and gridded data are involved, specifically:

  - Quality Panel (P0) for document preparation, review and validation;

  - Metadata (P3) for specific imagery description and cataloguing based on DGIWG Metadata Specifications (DMF);

  - Web Services (P5) for specific imagery and gridded data access through network, especially with DGIWG profile of WCS 2.0 or in support of P5-07 Sensor Web Enablement (SWE) for Defence project;

  - NATO Geospatial Information Framework (NGIF) / Defence Geospatial Information Framework (DGIF) integration.

5.2   Imagery and Gridded Data standards assessment

5.2.1   DGIWG Standards

5.2.1.1   To ensure interoperability in military context for the exchange of raster data, the DGIWG imagery and gridded data panel has developed a portfolio of standards (listed in Annex A) which consists of:

  - Two application profiles of standards: OGC GeoTIFF and OGC GMLJP2, encoding imagery formats.

  - A data model, its application schemas and encoding rules for elevation surface data (ESM), based on ISO 19123 schemas and addressing

elevation rectified grid coverages, point sets and Triangulated Irregular Networks.

- Three data product specifications implementation profiles for elevation data (DGED), raster maps (DRP) and Orthoimagery (DOP), based on the previous standards and including DGIWG DMF requirements for the metadata contents.

5.2.1.2   These standards rely as far as possible on the existing commercial and public domain standards in order to lower the cost of military geospatial systems, and to increase the ability for military organisations to be able to make use of civilian data, especially for those scenarios where civilian data may be the dominant source of data.

5.2.1.3   Therefore, the DGIWG IGD panel bases its recommendations of use and its standardization efforts, when necessary, on the following standards or formats.

5.2.2   Imagery and Gridded data reference models

5.2.2.1   The **ISO TC 211 19123 series of** standards define a reference model (part 1) and implementation schemas (part 2) for coverage geometry and functions. Its development is aligned with **OGC Coverage Information Schema (CIS)** which is the common schema used by OGC Web Coverage Service standard and its future successor OGC API Coverages.

5.2.3   Imagery and Gridded Data encodings

5.2.3.1   The following general purpose standardized civil or military formats are applicable to imagery and gridded data, with their key limitations, and have been adopted into the DGIWG standards as encoding profiles and product specifications:

- **GeoTIFF**: based on TIFF legacy format, aimed at georeferenced imagery and endorsed by OGC as a standard format.

- **GMLJP2**: OGC standard with JPEG2000 compression for encoding of geospatial raster, imagery or elevation data.

- **NSIF (STANAG 4545)**: NATO Secondary Imagery Format is a profile of the ISO/IEC 12087-5 Basic Image Interchange Format (BIIF), for georeferenced and georeferenceable imagery.

5.2.3.2   Other standards such as **netCDF** may also be considered for geospatial imagery, as well as **HDF-5** as data containers for imagery or scientific data.

5.2.3.3   Light Detection And Ranging (LiDAR) elevation point clouds are commonly encoded in **LAS Format Specification**, developed by the American Society for Photogrammetry and Remote Sensing (ASPRS), which has now become an OGC Community standard in its version 1.4 and is also of interest for IGD panel works on point clouds data.

5.2.3.4   The **OGC GeoPackage encoding standard** defines an open format for transferring geospatial information. A profile of this standard has been developed by DGWIG Web Services Panel (P5). The **OGC GeoPackage Extension for Tiled Gridded Coverage Data** defines the rules for encoding and storing tiled regular grid coverages into GeoPackage and is thus of interest for Imagery and Gridded Data dissemination.

6   Current responsibilities

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

6.2   More generally, the IGD Panel is responsible for surveying and tracking on the raster and gridded data domain, in order to incorporate new types of standards, formats and practices which could offer enhancements and advantages to DGIWG member nations.

7   Current and Planned Activities

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

7.1   Maintenance Work

7.1.1   The following table lists the DGIWG documents that P2 plans to review in the next 24 months.

Doc ID	Name	Task summary	Document type (Standard, Guidance note, etc.)	Last time reviewed

116-1	Elevation Surface Model (ESM) Standardized Profile	P2 to review and if appropriate update given the outcomes of point clouds white paper.	Standard profile	09/2020
116-2	Elevation Surface Model (ESM): GML Application Schema (v1.0.2)	P2 to review and if appropriate update	Standard profile	10/2020
116-3-1	Elevation Surface Model (ESM) - Encoding Rules - Part 1: Core (v1.1.1)	P2 to review and if appropriate update	Standard profile	10/2020
116-3-4	Elevation Surface Model (ESM) - Encoding Rules - Part 4: NSIF (v1.1.1)	P2 to review and if appropriate update	Standard profile	11/2020
907	DGIWG IGD Roadmap	P2 to review and if appropriate update	Roadmap	04/2023

Table 2 - Maintenance Activities

7.2 Development Work

7.2.1 The following table lists the technical developments that P2 plans to undertake in the next 24 months.

Req. No	Task Name	Task summary	Customer	Output (Standard, Guidance note, White paper etc.)	Due Date
N.A.	Polar Extension of DRP	Add Polar extension support to DRP product specification.	MN	Annex to the Standard or a specific document referenced by either DRP and DOP.	When qualified resource is available
N.A.	Polar Extension of DOP	Add Polar extension support to DOP	MN	Annex to the Standard or a	When qualified resource is available

Req. No	Task Name	Task summary	Customer	Output (Standard, Guidance note, White paper etc.)	Due Date
		product specification.		specific document referenced by either DRP and DOP.	
109	DGED 1.3	Add a 3-meter resolution level (5b) to DGED specification. Propose a simplified recommendation for tiling schemes.	MN	Standard	2025
94.	Elevation Surface Model (ESM) Encoding Rules GeoPackage (DGIWG 116-3-5)	Development of a new part of Elevation Surface Model defining the encoding rules of elevation data using GeoPackage within the Defence Environment in addition to the requirements defined in DGIWG 126 ED 1.1.	MN	Standard	2025
107	GeoTIFF Profile for Georeferenced Imagery (v2.4)	Enhancement of GeoTIFF Profile for Georeferenced Imagery to support Cloud Optimized GeoTIFF (COG) with BigTIFF specification and to propose some new guidance regarding the	MN	Standard	2025

Req. No	Task Name	Task summary	Customer	Output (Standard, Guidance note, White paper etc.)	Due Date
		use of LZW predictor.			

Table 3 - Development Activities

8   Emerging Concepts and Associate Standards

8.1   Medium term assessment

The key trends identified by the P2 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.

8.1.1   Definite Trend 1: 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. Furthermore, point cloud may also come from many other sources and measuring devices and sensors and can represent (among others): Elevation data, Seismic data, Bathymetric data, Meteorological data, and Fixed/Mobile consumer sensor. Many of them are usually captured by sounding devices, stereo imagery, etc.

- **Benefits and 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 Cloud Optimized Point Cloud (COPC), Entwine Point Tile (EPT) or GeoParquet.

  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. A white paper for standardization needs regarding Point Cloud has been written by DGIWG IGD Panel and is expected to help initiating standardization work items.

8.1.2 Definite Trend 2: Geo Big Data and its impact on DGIWG Standards

- **Description:** With cloud storage capabilities for big data, some well-known raster file formats or specifications such as GeoTIFF or LAS (for point cloud data) are being enhanced (see Cloud Optimized GeoTIFF or Cloud Optimized Point Cloud) to propose an optimized internal organisation of the data to allow a targeted access to the part of the file that is needed. With the same idea, though not georeferenced, the emerging Zarr format is also designed to store chunked, compressed, N-dimensional arrays and has been endorsed by OGC as a community standard. A GeoZarr SWG has also been launched by OGC to standardize the georeferencing of data into Zarr.

- **Benefits and relevance to the Geospatial Defence Community:** As GeoTIFF is one of the encoding formats recommended by DGIWG for use by Geospatial Defence Community and adopted in gridded Defence product specifications, it seems relevant for the P2 panel to pay attention to Cloud Optimized GeoTIFF (COG) and its homologous formats in order to consider relevant evolutions of its standards taking these optimizations into account.

- **Level of Maturity:** This is a relatively mature trend (COG is already supported by many software libraries and editors) and it should be considered for adoption by the defence community.

8.1.3 Definite Trend 3: Geo-enabled HTJ2K (ISO 15444-15)

- **Description:** This extension of JPEG 2000 (J2K) provides high performance (in terms of decompression - display speed – or data flow in terms of frames per second for digital video imagery) improved by an order of magnitude as regards JPEG 2000, though it fits in the framework of ISO 15444 standards (including JPIP). A White paper "High Throughput JPEG 2000 (HTJ2K) and the JPH file format: a primer" is available at http://ds.jpeg.org/whitepapers/jpeg-htj2k-whitepaper.pdf. Kakadu is supporting it since version 8.1, and there are also open source implementations available that are also supporting it fully or partially. The capacity of HTJ2K is being integrated in BIIF Profile of JPEG 2000 (BPJ2K 01.20) and Joint BIIF Profile standards on which NATO STANAG 4545 is relying. It will also be part of the authorized codecs for the (GEOINT Imagery Media for ISR) GIMI

Format, which will be the base of Next Generation of ISR Imagery Standard (NGIIS). Geo-enablement of this emergent HTJ2K is considered of interest.

- **Benefits and relevance to the Geospatial Defence Community:** As GMLJP2 is one of the encoding formats recommended by DGIWG for use by Geospatial Defence Community and adopted in gridded Defence product specifications, it seems relevant for the P2 panel to pay attention to HTJ2K in order to consider relevant evolutions of its standards taking these optimizations into account.

- **Level of Maturity:** This is a relatively mature trend and it should be considered for adoption at medium term by the defence community.

8.1.4   Definite Trend 4: 3D imagery (perspective imagery)

- **Description:** With the introduction of augmented reality data into virtual reality activities (simulation, training, scenario analysis, etc.) Stereo (or 3D) imagery and Digital Surface Models (DSM), such as textured Triangulated Irregular Networks (TIN), Textured meshes, Gaussian splatting or Point clouds to represent terrain or urban scenes, is foreseen to become more relevant in the future.

- **Benefits and relevance to the Geospatial Defence Community:** In Germany, the Bundeswehr Geoinformation Centre (BGIC) expressed some interest (though not in a situation to contribute any DGIWG project), and has an internal project on this topic, for which the OGC Community Standard "Indexed 3D Scene Layers" (I3S) is considered as a candidate standard of interest. Canada and France also expressed an interest. Another OGC community standard of interest is 3D Tiles (OGC 22-025r4).

- **Level of Maturity:** This is a relative mature trend and it should be considered for adoption at medium term by the defence community

8.2   Long Term Assessment

The key trends identified by the P2 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   Definite Trend 5: Integration with Motion imagery

- **Description:** 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).

Integration with motion imagery is also a topic that is the base of the Next Generation of ISR Imagery Standard (NGIIS) that are developed by NGA (US) and DSLT (UK) and are intended to be the follow-on to NITF/NSIF ISR Standards. They are built on top of a common base of MPEG Standards enhanced by ontology and metadata information.

- **Benefits and relevance to the Geospatial Defence Community:** 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 Unmanned Aerial Vehicles (UAV) with these capabilities make this a relevant trend.

- **Level of Maturity:** This is an emerging trend and the development of these technologies should be monitored

8.2.2   Definite Trend 6: Geo AI

- **Description:** The development of Artificial Intelligence (AI) capabilities has considerably accelerated these latest years leading to the availability of AI based operational solutions in the civil domain. Geospatial data are also concerned by this technology regarding automatic interpretation and classification or generation of imagery data, detection of changes or shapes in large imagery collections and many other potential application domains that extend beyond imagery data.

  Regarding standardization, in the civil domain, OGC has led a task in Testbed-18 regarding Machine Learning Training Data (see Engineering Report: https://docs.ogc.org/per/22-017.html) and published the TrainingDML-AI Standard that provides detailed metadata for formalizing the information model of training data. In the military domain, NATO has defined an AI Strategy and is evaluating the impact of AI on JISR standards and activities.

- **Benefits and relevance to the Geospatial Defence Community:** The application domains of GeoAI mentioned above are of interest for Defence usages. Regarding the community, there might be some interest in sharing common practices or datasets in machine learning processes for data production or detection purposes. More generally, it is important that the evolution of Geo AI trend should be monitored at a cross-panel level.

- **Level of Maturity:** This is an emerging trend and the development of these technologies should be monitored.

8.2.3   Definite Trend 7: Geo-enablement and usage of the HEIF Format

- **Description:** High Efficiency Image File Format (HEIF) is a digital container format for storing individual digital images and image sequences. The standard covers multimedia files that can also include other media streams, such as timed text, audio and video. It is defined by ISO/IEC 23008-12 (MPEG-H Part 12).

  It serves as the base of the Next Generation of ISR Imagery Standard (NGIIS) for the GIMI Specification developed by NGA. OGC is also considering to develop a new standard in order to enable the georeferencing of HEIF images.

- **Benefits and relevance to the Geospatial Defence Community:** This format is about to become the basis of new STANAGs related to the intelligence domain. It also allows to integrate richer semantics and annotations associated to the images with the help of metadata container. Hence this is a topic of interest for defence community.

- **Level of Maturity:** This is an emerging trend and the development of these technologies should be monitored.

ANNEX A   Artefact Responsibility

Table A1 contains a list of completed DGIWG documents and artefacts that the P2 is responsible for maintaining. (***Note*** *this table is extracted from the DGIWG PoW and should not be updated in isolation)*

Doc ID	Document Title	Published Date	Edition Date	Review Cycle	Review by Date
104(2)	DGIWG Profile of JPEG 2000 for Georeferenced and Referenceable Imagery (v2.1.3)	19/04/2023	19/04/2023	3 years	19/04/2026
108	GeoTIFF Profile for Georeferenced Imagery (v2.3.1)	07/07/2020	07/07/2020	3 years	01/07/2023
116-1	Elevation Surface Model (ESM) Standardized Profile (v1.1.1)	17/09/2020	17/09/2020	3 years	01/10/2023
116-2	Elevation Surface Model (ESM): GML Application Schema (v1.0.2)	02/10/2020	02/10/2020	3 years	01/10/2023
116-2-SD1	Elevation Surface Model (ESM) GML schemas	02/10/2020	02/10/2020	3 years	01/10/2023
116-3-1	Elevation Surface Model (ESM) - Encoding Rules - Part 1: Core (v1.1.1)	02/10/2020	02/10/2020	3 years	01/10/2023
116-3-2	Elevation Surface Model (ESM) - Encoding Rules - Part 2: GeoTIFF (v1.1.1)	02/10/2020	02/10/2020	3 years	01/10/2023
116-3-3	Elevation Surface Model (ESM) - Encoding Rules - Part 3: GMLJP2 (v1.1.1)	02/10/2020	02/10/2020	3 years	01/10/2023
116-3-4	Elevation Surface Model (ESM) - Encoding Rules - Part 4: NATO Secondary Image Format (NSIF) (v1.1.1)	19/11/2020	19/11/2020	3 years	01/10/2023
250	Defence Gridded Elevation Data (DGED) Product Implementation Profile (v1.2.1)	02/10/2020	02/10/2020	3 years	01/10/2023
254	Defence Raster Product (DRP) Implementation Profile (v1.0)	29/06/2020	12/06/2020	3 years	01/07/2023
255	Defence Orthoimagery Product (DOP) Implementation Profile (v1.0)	05/05/2021	05/05/2021	3 years	01/05/2024
907	DGIWG IGD Roadmap	24/04/2023	24/04/2023	yearly	10/2024

Table A 1: Artefacts for which P2 is responsible