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Item 15 of the provisional agenda*

**Implementation and adoption of standards for the
global geospatial information community**

Implementation and adoption of standards for the global geospatial information community

Note by the Secretariat

Summary

The present paper contains the report prepared jointly by the International Hydrographic Organization, technical committee 211 of the International Organization for Standardization (ISO) and the Open Geospatial Consortium on the implementation and adoption of standards for the global geospatial information community for consideration by the Committee of Experts on Global Geospatial Information Management.

At its thirteenth session, held from 2 to 4 August 2023, the Committee of Experts adopted decision 13/113, in which it expressed its appreciation for the continued alignment of the standards development organizations with the work of the Committee of Experts and welcomed the many examples of how countries were using the standards for advancing data access and interoperability, demonstrating the benefits of implementing geospatial standards to ensure standards accountability and compliance of practice in modern information systems and applications across many business and government sectors, such as smart cities, urban digital twins, intelligent transport systems and energy. The Committee encouraged the broad use of standards and the standards guide to support the implementation of standard-based solutions that ensure interoperability, data-sharing and flexibility to adapt to changing data sources and technologies, noting that the real value of standards was in their actual use in the process of implementation and operation.

The Committee further encouraged Member States and the United Nations Global Geospatial Information Management regional committees to participate in the continued development, maintenance and advancement of geospatial standards in collaboration with the standards development organizations, to increase the quality, interoperability and application of standards, and to provide practical examples and best practices on the implementation of geospatial standards to support the measurement and monitoring of the Sustainable Development Goals.

In this present report, the International Hydrographic Organization provides information on its continuing efforts to advance the S-100 Universal Hydrographic Data Model to support the creation and maintenance of interoperable maritime data product services that are compliant with the ISO 19100 series of geographic information standards. The organization reports that edition 5.1.0 was released in October 2023, and several S-100-based product specifications are being developed and implemented in collaboration with several international organizations, including entities of the United Nations system and partners such as the International Association of Marine Aids to Navigation and Lighthouse Authorities

* E/C.20/2023/1

and the World Meteorological Organization. The International Hydrographic Organization also reports that it has established a freely available training resource on maritime spatial data infrastructure to assist its members in aligning their country-level work to the United Nations Integrated Geospatial Information Framework and the Operational Framework for Integrated Marine Geospatial Information Management.

Technical committee 211 of ISO, in the report, provides information on its activities with entities of the United Nations system and partners, including supporting the modernization of the geodetic infrastructure in coordination with the United Nations Global Geodetic Centre of Excellence. The committee discusses its progress in the development of the ISO 19152 Land Administration Domain Model, of which part 1 has been published and part 2 will be published later in the year. This development allows better integration of land and sea boundaries and supports the implementation the Framework for Effective Land Administration, as well as the Operational Framework for Integrated Marine Geospatial Information Management. The committee also discusses the development of ISO 19144 on land cover and land use, in conjunction with the Food and Agriculture Organization of the United Nations, of which parts 1 and 2 have been published and part 3 should be published by August 2024. The committee also highlights its work with the Expert Group on the Integration of Statistical and Geospatial Information on the review of the Global Statistical Geospatial Framework.

In this report, the Open Geospatial Consortium discusses its focus on developing and testing open geospatial application programming interface standards via pilots, projects and testbeds under its collaborative solutions and innovation programme, covering several areas including climate services, disasters, the marine environment, digital twins and the built environment. The Consortium emphasizes the integration of geospatial information with statistics and other data under the findable, accessible, interoperable and reusable data principles. The Consortium reports that it is witnessing an acceleration in the advancement of standards and the creation of new working groups, such as those relating to the geospatial indicator standardization effort. The Consortium further reports that it continues to enhance interoperability with its standards, as well as the International Hydrographic Organization and ISO standards, thereby ensuring a cohesive framework for geospatial data utilization and standardization, in support of the global geospatial information agenda.

Furthermore, in this report, the three standards development organizations provide an overview of their work to support the measurement and monitoring of the Sustainable Development Goals and present how they are working to practically strengthen their interaction with the regional committees, functional groups and thematic networks of the Committee of Experts. The report also includes practical examples of the use of geospatial standards in support of the Goals, including a collection of user stories showing how standards have helped countries work towards specific Goals.

I. Introduction

1. The International Hydrographic Organization (IHO), the Technical Committee 211 of the International Organization for Standardization (ISO/TC 211), and the Open Geospatial Consortium (OGC) work in partnership to leverage their respective missions and membership expertise to advance Findable, Accessible, Interoperable and Reusable (FAIR) principles and standards to meet the goals and objectives of the Committee of Experts. The three standards development organizations (SDOs) continue to increase cooperation through their formal liaison agreements and joint program initiatives to produce standards and good practice recommendations that could not be fully achieved by working in isolation. The goal is to ensure Member States take a high-level policy decision globally to ensure that open standards are the default starting point for all geospatial and location requirements.

2. The Committee of Experts is invited to take note of the present report and to express its views on the activities and plans of the three standards development organizations and their contribution to the development, implementation and adoption of open standards for the global geospatial information community. Points for discussion and decision are provided in paragraph 38.

II. Update from the Open Geospatial Consortium (OGC)

Introduction

3. The OGC and its more than 480 members from across the private, public and academic and research sectors have guided the advancement of open standards and associated good practices to make geospatial information FAIR in support of global requirements. During the intersessional period, advancing open and FAIR principles continued to accelerate with a record number of standards advancing and new working groups established.

4. Through its member meetings, workshops, forums, summit events, and practical results demonstrated via its 24 ongoing Collaborative Solutions and Innovation Program (COSI) initiatives covering a broad range of topics, OGC is addressing an expanding range of geospatial interoperability challenges faced by the international community. Over the past year, OGC has focused on a range of topics relevant to the United Nations Sustainable Development Goals (SDGs) including a multi-year continued focus on improved support for disaster response, increased coordination within the marine domain, and innovation related to climate services. OGC is continuing with its advancement of an open application Programming Interface (API) Standards suite - a modernization and expansion of OGC's Web Services Standards - designed to simplify development and deployment, increase the flexibility of applications, and to efficiently leverage big data and cloud native infrastructure.

Adoption and implementation of OGC General Purpose Geospatial Standards

5. OGC has now completed the OGC API Standards that offer equivalent functionality to the OGC Web Service Standards such as Web Map Service (WMS), Web Feature Service (WFS), and others, OGC API - Features, OGC API - Tiles, OGC API - Maps, OGC API - Processes, OGC API - Environmental Data Retrieval and OGC API - Common now being implemented in major commercial and open-source geospatial technologies supporting the global community.

6. The OGC APIs for Features and Tiles are helping to bring fundamental geospatial data to all types of users, from geospatial professionals to consumers in a simple and flexible manner that was impossible with the previous generation of standards. This approach enables better access to geographic information and decision-making by citizens, regardless of their level of technological sophistication.

7. As part of the evolution of the OGC API - Environmental Data Retrieval¹ standard, a new part has been developed to allow a publish-subscribe (pub-sub) interface to multidimensional data. This capability is ideal for notification of changes to climate and environmental data. More importantly, the pub-sub capability has been designed to be sufficiently flexible to work with other OGC API Standards and support the syndication of geospatial content of all types.

8. As part of the OGC API effort in OGC, two additional standards are approved or being finalized. OGC API - Moving Features provides web access to high-volume, high-velocity moving feature data, such as wildlife or human movement, mass evacuations from disasters, or logistics deliveries. In the final stages of development is the OGC API - Connected Systems Standard which is modernizing the more complex OGC Sensor Web Standards and allows sophisticated networking and spatial reasoning of sensor data.

9. OGC is nearing completion of the Features and Geometries JSON (JSON-FG) standard. The standard extends GeoJSON, a widely used Standard from the Internet Engineering Task Force (IETF), to support Coordinate Reference Systems (CRSs) and complex geometric representations of data. GeoJSON files are in wide use and will be fully valid instances of the JSON-FG Standard.

Adoption and implementation of OGC Domain-Specific Standards

10. OGC continues to support SDGs related to sustainable climate and environmental objectives. A joint activity between ISO / TC 211 is to develop an Analysis Ready Data (ARD) Standard to assist in the consistent preparation of source data for further processing to develop insights into a variety of spatially related topics. Such ARD also allows for the development of indicators of impact, which will be standardized through the new OGC Geospatial Reporting Indicators Standards Working Group. New research is also underway in extending the OGC Water Markup Language suite of Standards used to describe surface and groundwater resources. The next proposed extension is one for describing water quality.

Engagement with regional committees of UN-GGIM and other international bodies

11. Beyond coordination with ISO/TC 211 and IHO, the OGC works with a number of other standards-setting or domain-focused organizations to ensure that common principles are in place for the use of location information. For example, OGC and SMART International are investigating the use of APIs to access diverse representations of the built environment (e.g., buildings and infrastructure) in common environments to improve collaboration without the need for expensive data transformations. OGC is also engaged with ISO/TC-204 (Intelligent Transport Systems) to assist in developing implementable instances of standards used in land and sea transport, including for autonomous vehicles.

Compliance Testing Resources

12. As part of OGC's compliance testing and certification program², OGC continues to publish compliance tests for standards, consistently soon after the standards are published. These tests are open-source software and permissively licensed to allow developers to test their own work before creating software. OGC also offers a certification program using the tests and OGC evaluation of test results to formally mark software that is proven to properly implement OGC Standards.

Innovation and standards development

13. Unique to OGC is the COSI program, which brings sponsors and participants together to collectively work on solving common problems across multiple domains. The

¹ <https://ogcapi.ogc.org/edr/>

² <http://cite.opengeospatial.org/teamengine/>

COSI program uses real-world scenarios and demonstrations of results and is closely connected to the standards program. Testing OGC (and IHO and ISO) standards using practical use cases results in improvements based on implementations, this allows to shorten the adoption cycle of new and existing standards.

14. During the intersessional period, and carrying on into 2025, OGC leads or participates in the following initiatives:

- (a) ACCORD - The project supports a new climate-neutral construction approach. The aim is to digitize approval and compliance processes in the planning of construction projects based on open and neutral standards for data exchange. This supports the targets of the EU Green Deal as well as the new European Bauhaus initiative and the goals of the United Nations Framework Convention on Climate Change (co-funded by the European Union, grant 101056973)
- (b) All Data for Green Deal - Man-made climate change is the great challenge of our time. The All Data for Green Deal (AD4GD) project defines the European Commission Climate Data Space and explores how FAIR approaches can help integrate data better to make more profound decisions at the regional and national level to mitigate climate change. This project is co-funded by the European Union's Horizon 2020 research and innovation programme under grant agreement No. 101061001.
- (c) CHEK - The goal is to facilitate digital building permit procedures for municipalities. CHEK explores how to integrate geodata with Building Information Model (BIM) data. The CHEK model contains all information about the building's components, materials and properties as well as its location and orientation. By applying the latest semantic web research, CHEK enables automated digital building permits using standards-based processing pipelines. (This project has received funding from the European Union's Horizon Europe programme under Grant Agreement No.101058559).
- (d) Climate and Disaster Resilience Pilot - designed to accelerate collective readiness for accessing, fusing, and analyzing data from the climate change services and modeling communities with Earth observation and social science data to contribute to the global push for achieving climate resilience. The pilot project explores how climate data, heat island data, and other important data can be used most effectively. The pilot project applies generative AI to respond to natural language questions.
- (e) CLIMOS - aims to help mitigate the emergence, transmission, and spread of pathogens (sand fly focus). The project develops guidelines and best practices on how data from various sources can be linked together most efficiently. This project is co-funded by the European Union's Horizon 2020 research and innovation programme under grant agreement No. 101057690
- (f) CLINT - Climate Intelligence - The project develops an artificial intelligence framework (Climate Intelligence) composed of machine learning techniques and algorithms to process big climate datasets for improving climate science in the detection, causation, and attribution of extreme events. This project is co-funded by the European Union's Horizon 2020 research and innovation programme under grant agreement No. 101003876
- (g) DEMETER - This large-scale project developed an agriculture information model and deployed a farmer-centric interoperable smart

farming IoT-based platform (delivered through a series of 20 pilots across 18 countries). DEMETER is funded by the European Union's Horizon 2020 research and innovation programme under grant agreement No. 857202

- (h) Disaster Pilot 2023 – This pilot is prototyping the provision of online and offline Earth observation, health, and other critical data for first responders. A multi-year effort, the OGC Disaster Pilot 2023 continues, with a focus on Analysis Ready Data (ARD) and decision-ready information (DRI).
- (i) DIS4SME -DIS4SME provides high-quality specialized training courses on location data interoperability. Its main objective is to educate and retrain entrepreneurs, managers, employees, and job seekers through such courses. The project ties in with the EU's strategy for digital transformation. This project is co-funded by the European Union's Horizon 2020 research and innovation programme under grant agreement No. 101100762
- (j) EuDataHub - OGC's standards and software architecture know-how to build the next generation earth observation data platform in the United Kingdom, integrating the Spatio-Temporal Asset Catalog (STAC), AWS cloud resources such as Kubernetes and Cloudfront, with OGC APIs and other standards.
- (k) EuroGeoSec - The project builds a good understanding of the EO resources (data, infrastructures, technologies, stakeholders, skills...) available in Europe at the National and Regional level as well as how they can interact with other regions and globally via GEO to foster the EO Market for a faster uptake. This project is co-funded by the European Union's Horizon 2020 research and innovation programme under grant agreement No. 101134335
- (l) iGuide - OGC is involved in this National Science Foundation (NSF)-funded project to explore how High-Performance Computing Platforms can be used in data infrastructures most efficiently.
- (m) IHO-OGC Federated Marine Spatial Data Infrastructure Pilot (FMSDI) - The Federated Marine SDI Demonstration (FMSDI) pilot explores the integration of the land perspective with the sea perspective. As such, it brings together two distinct domains in one of the environments most sensitive to climate change: the land-sea interface. The pilot continues into 2025 with more focus on feature type catalogs and knowledge graphs to explore linked data potentials and challenges.
- (n) ILIAD – Digital Twin of the Ocean - Over 50 partners are building the solutions and infrastructure to monitor the marine environment with their own and public datasets and services. OGC is involved in several areas focusing on Social Science and Digital Twin of the Ocean APIs. Standards-based methods to discover, access, and process data of various types and in an appropriate variety of formats will enable open ecosystem integrations and the market of applications. These will be developed on the OGC APIs linked to the multimodal semantic layer provided by the OGC Definition Server. This project is co-funded by the European Union's Horizon 2020 research and innovation programme under grant agreement No. 101037643
- (o) InCASE - Earth observation data and measurement results must be discoverable and well documented. To do so, they must comply with relevant standards to ensure compatibility between different data sources. Compliance with such standards significantly improves the

value of the data. Users can thus develop different services and monitor policy objectives. The InCASE project is investigating how these principles can be applied specifically to data measurements from sensors, etc., in the field. This project is funded by the European Environment Agency and OGC's main contribution to GEO and GEOSS.

- (p) Geotech Interoperability Experiment (IE) - This experiment contributes to improving GIS - BIM connectivity to exploit the standardization resources already available from the OGC and other organizations as an input for resources to share geotechnical engineering data in the appropriate context for users.
- (q) OGC Sprints - OGC Sprints are collaborative events driven by rapid code development to implement and test specific capabilities of a technical approach or standard. Most OGC API Standards are refined and tested via these Sprints so that each final standard is proven to be implementable and useful.
- (r) OGC Testbed-19 - OGC Testbeds are OGC's largest Innovation Program initiatives. They boost research and development to make location data and information more FAIR. Testbeds provide a unique opportunity for sponsors to tackle location data and processing challenges together with the world's leading geospatial IT experts. Testbed 18 focused on three high-level threads: Advanced Models and Data, Catalogs, filtering, and Moving Features and Future of Open Science and Building Energy Interoperability.
- (s) OGC Testbed-20 - This year's testbed addresses Interoperability, Provenance, and Trust, Geodatacubes, High-Performance Computing, and new imagery formats for better information storage and exchange.
- (t) Open Science Persistent Demonstrator - This pilot makes interoperability more tangible. The pilot explores how data and services can be used across cloud platforms in single workflows.
- (u) Urban Digital Twins Interoperability Pilot - Urban Digital Twins will be developed, but no single city can be expressed within a single twin. This project explores how multiple digital twins can be integrated using several smart city challenges.
- (v) USAGE -The Horizon Europe project USAGE (Urban Data Space for Green Deal) develops solutions and mechanisms to make city-level environmental and climate data available to citizens. This project is co-funded by the European Union's Horizon 2020 research and innovation programme under grant agreement No. 101059950
- (w) NSDI 2.0 - The Next Generation National Spatial Data Infrastructure research brings existing SDIs to the next level. Addressing previously underrepresented topics such as governance, customer-targeting design, knowledge infrastructure and geospatial ecosystem perspectives lead to the development of new best practices and guidelines for more efficient SDIs.

III. Update from Technical Committee 211 of the International Organization for Standardization (ISO/TC 211)

Introduction

15. ISO/TC 211 Geographic information / Geomatics³ manages ISO's geospatial standards, with the vision to support a sustainably prosperous future by providing, in cooperation with other organizations, a set of standards that enable better management of geographic information. The ISO/TC 211 develops geospatial standards through collaboration, harmonization, and outreach. The specific focuses of ISO/TC 211 are on metadata and data quality in support of the FAIR Principles - that data should be findable, accessible, interoperable and reusable. The work with other standards bodies focuses on ensuring they can make the best use of geographic information.

16. ISO/TC 211 has been working with the UN-GGIM Expert Group on the Integration of Statistical and Geospatial Information on the revision of the Global Statistical Geospatial Framework (GSGF) and has been updating ISO 19157 Data quality and this year hope is to launch an online register of data quality measures, with machine-readable definitions. The ISO Registration Authority on this matter is the Open Geospatial Consortium.

17. ISO/TC 211 now consists of 39 participating and 34 observing members which are national standards bodies, having welcomed Luxembourg and Barbados as new members in 2023. ISO/TC 211 collaborates with numerous liaisons, including ISO committees and external organizations. Key internal ISO liaisons include integrated transport, digital twins, smart cities, smart farming, climate change and ESG (environmental, social, governance). For more information, the Strategic Business Plan is available on the ISO/TC 211 website. Freely available resources such as UML models and XML schemas for supporting standards implementations are also found on ISO/TC 211 website. The committee remains active in the ISO work towards machine-readable standards and the ISO online standards development tool pilot.

18. ISO as a whole is now more focused on sustainability, particularly climate change in support of the United Nations Call for Action on Adaptation and Resilience. The focus is on standards in energy production, transport, and construction. The ISO Climate Change Coordination Committee recognizes the value of geospatial information and standards in planning and monitoring sustainability, and ISO/TC 211 is working with them to improve its portfolio on this topic.

Sustainable Development Goals (SDGs).

19. Geospatial standards support the broader objectives of the 2030 Agenda for sustainable development as general purpose geospatial standards are important for the industry and infrastructure, and those standards in direct support of the activities of UN-GGIM, specifically in the areas of geodetic referencing, land administration, land cover and land use, and addressing. For example, the UN Convention on Combating Desertification uses ISO 19144 to integrate land cover information; the standard was prepared and revised jointly with the Food and Agriculture Organization. ISO provides tools to help technical committees map their projects to the SDGs⁴. ISO/TC 211 collects user stories showing how standards have helped countries work towards specific SDGs; see <https://committee.iso.org/sites/tc211/home/standards-in-action/united-nations.html>.

³ <https://committee.iso.org/home/tc211>

⁴ <https://www.iso.org/sdgs.html>

General purpose geospatial standards and aligning with the business environment.

20. Several geospatial standards are so elementary that users are not always aware of them being implemented. Standards that describe data in a uniform way (specifications, metadata and quality, and geographic point location by coordinates) are widely used. Other examples of these hidden standards cover the process of relating national coordinate reference systems to global geodetic reference systems (so that two or three numbers can represent a place on the Earth), and the calibration of remote sensing devices. As geospatial technology becomes mainstream, some of the “specialist” standards are implemented in more mainstream software, such as the common implementation of spatial technology in relational databases. As the information technology environment changes, geospatial standards need to change; for example, ISO/TC 211 has begun its first project looking at JSON encoding. Working with the European Commission, ISO/TC211 has published a report⁵ on using existing geospatial standards to publish data into generic “data spaces.”

Participation in standardization and advancing implementation.

21. The requirements for standardization are identified by the user community and therefore stakeholder participation is essential. In many cases, international organizations develop domain specifications based on the ISO/TC 211 and OGC standards, for example, the IHO, the World Meteorological Organization (WMO), and the Defence Geospatial Information Working Group (DGIWG). The 2023 Standards in Action seminar attracted some twenty presentations with speakers from nine countries, covering ‘digital twins and geospatial standards’, ‘technologic trends’, ‘GIS for digital transformation’, ‘smart mobility’, and ‘ISO and sustainability’; the presentations will be available on the ISO/TC 211 website.

Coordinate Reference Systems.

22. ISO/TC 211 supports the implementation of the Global Geodetic Reference Frame (GGRF) by developing standards, such as:

- (a) ISO 19111 “Referencing by coordinates”, which describes coordinate reference systems and transformations between them - how to represent a location in numbers.
- (b) ISO 19161-1 “International terrestrial reference system (ITRS)”, which adopts the work of the International Union of Geodesy and Geophysics (IUGG), the International Association of Geodesy (IAG) and the International Astronomical Union (IAU) to show how to “realize” national and regional coordinate reference systems in alignment with the worldwide ones, such as GNSS.
- (c) By the time of the meeting, work should have started on ISO 19161-2 Geodetic references — Part 2: Unique identification of geodetic ground stations in collaboration with the International Association of Geodesy (IAG) and the International Earth Rotation and Reference Systems Service (IERS), this will extend and modernize the way that ground geodetic stations are identified. They form a key part of the GGRF.
- (d) ISO 19127 “Geodetic Register” which specifies the ISO Geodetic Register (ISOGR) and its associated Control Body. The Control Body consists of convenors nominated by the International Association of Geodesy (IAG) and of international geodetic experts. The register contains official parameters and transformations for national and regional coordinate reference systems, and is freely available online.

⁵ https://committee.iso.org/files/live/users/fh/aj/aj/tc211contributor%40iso.org/files/EU/ISO-TC211_N5971.pdf

Land Administration

Having engaged OGC, IHO, the International Federation of Surveyors (FIG), the United Nations Office of Legal Affairs' Division for Ocean Affairs and Laws of the Sea (DOALOS), the World Bank, the Food and Agriculture Organization (FAO), and UN-Habitat, ISO TC/211 is running an extensive revision of ISO 19152:2012 "Land Administration Domain Model (LADM)" with confidence that the proposed new parts to this standard will cover the organizational requirements. The result of this revision is creating a multi-part standard: 1) General Conceptual Model (published in January 2024); 2) Land Registration; 3) Marine Georegulation (likely to be published before the UN GGIM meeting); 4) Valuation Information; 5) Spatial Planning; and, 6) Implementations. Parts 2, 4 and 5 should be published in 2025. Parts 2, 4, and 5 should be available for public comment (ISO Enquiry Stage) by the time of this meeting. A proposal for Part 6 is under preparation. ISO LADM supports the United Nations Framework for Effective Land Administration (FELA) and the Social Tenure Domain Model (STDM).

Land cover and land use

23. Land cover and land use (LCLU) are essential and fundamental data themes used by millions of professional users globally across a wide variety of applications. While the explosion of Location Intelligence tied to these essential data layers continues at a pace, the growing need for an agreed upon LCLU meta language is more urgent than ever, to facilitate international analysis. ISO 19144-2:2012 "Geographic information - Classification systems -- Part 2: Land Cover Meta Language (LCML)" was developed under the leadership of FAO. FAO is leading the revision, including developing ISO 19144-3, a similar meta language standard for Land Use. The revised ISO 19144-2 was published in December 2023. ISO 19144-3 should be published by the time of the meeting and part 4 is underway to establish a register of land cover and land use classifications.

Addressing

24. An address provides structured information for the unambiguous determination of an object, such as a house or apartment building. Addresses are essential for the management of cities, for governance and public administration generally, for service delivery in the public and private sectors, and they can give people status or (legal) identity in society. ISO 19160-2 supports the Universal Postal Union's initiative, "Addressing the World – An Address for Everyone", which promotes the establishment of national addressing infrastructures to the benefit of all. The multi-part ISO 19160, Addressing, provides the standards required for a country's addressing infrastructure, such as a conceptual data model; terminology; good practices for assigning and maintaining addresses; how to measure the quality of address data; and international postal addressing, the latter jointly developed with the Universal Postal Union (UPU).

25. ISO 19160-2 Addressing – Part 2: Assigning and maintaining addresses for objects in the physical world was published in November 2023. ISO 19160-2 specifies how to plan, implement, and maintain addresses and corresponding address data to gain maximum benefits for governance and society in the long run. The tool allows governments to measure the objectives, principles, and goals conformance of their address policies for a good practice and governance framework. This standard supports the first goal of the UN-IGIF, namely, enabling geospatial (address) information governance, policy and institutional arrangements that ensure effective geospatial (address) information management, accommodating individual organizational requirements and arrangements, and aligning to national and global policy frameworks. The standard is also useful for those involved in slum upgrading, as addresses are often assigned when housing conditions in settlements are being improved.

IV. Update from the International Hydrographic Organisation (IHO)

Marine Geospatial Framework

26. The IHO continued to work on its S-100 Universal Hydrographic Data Model framework to support the creation and maintenance of interoperable maritime data product specifications compliant with the ISO-19100 series of geographic information standards. The S-100 infrastructure which includes the Geospatial Information Registry Feature Catalogue and Portrayal Catalogue builder has been developed and is now embedded into the process of the development and maintenance of data product specification. S-100 based product specifications assigned to IHO, the International Association of Light Authorities (IALA), the Intergovernmental Oceanographic Commission (IOC), the Inland ENC Harmonization Group (IEHG), the World Meteorological Organization (WMO), the International Electrotechnical Commission (IEC) and NATO are being maintained on the IHO website - Edition 5.1.0 of S-100, released in October 2023, represents the culmination of experiences of the past years in testing and development against S-100. Several extensions have been incorporated in order to support the enhancement of standards based on the S-100 framework with requirements from stakeholders to meet safety and efficiency in digital marine products. With Edition 5.2 expected in 2024, new capabilities will be added, including real-time data integration for water levels, streaming service delivery, enhanced data portrayal mechanisms and enhanced encryption to support data authentication and cybersecurity.

Interoperability in the navigation system

27. IHO has developed the S-98 specification for data product interoperability in S-100 navigation systems to de-clutter displays, reduce information overload, resolve conflicts, and improve the overall quality and clarity of information presentation to mariners when multiple S-100 based data products are simultaneously displayed on-screen data product. The specification describes interoperability for S-100 based product specifications - S-101 Electronic Navigational Chart, S-102 Bathymetric Surface, S-104 Water Level Information, S-111 Surface Current and S-129 Under Keel Clearance Management.

Product standards development

28. S-100 based product specifications have been developed and tested according to the S-100 Implementation Decade (2020-2030) roadmap. Edition 1.2 of the premium product S-101 ENC was released in March 2024. Edition 1.0 of S-164 Test Data Sets for S-100 navigation systems based on the S-100 related products to be used for navigation published in March 2023 for implementation and testing purposes. The work on the product specification S-130 Polygonal Demarcations of Global Sea Area, which is primarily intended for encoding the extent of global sea area using a system of unique numerical identifiers pushed Ed.1.0 to test further by the implementers.

Testbed and Innovation Program

29. IHO operates a project named S1OOP - S-100 Open Online Platform that is aimed to be the foundation for a digital ocean and accelerate the wide adoption of the S-100 hydrographic framework by jointly developing and making available the technical requirements needed to overcome any S-100 implementation barriers. The project installed four themes, Theme 1 - Online viewer, Theme 2 – Data Production and Protection, Theme 3 – Open-source management, Theme 4 – Knowledge and Capacity. The new Joint IHO-Singapore Innovation and Technology Laboratory (IHO Lab) established in Singapore in October 2021 is aimed to accelerate innovation in the field of hydrography through sandbox implementation of new S-100 standards under construction. The IHO Lab has carried out four projects: the automated conversion of S-57 Electronic Navigation Chart (ENC) to S-101 next generation ENC, the development of a digital infrastructure for S-131 marine harbor infrastructure, the S-100 ECDIS capable of displaying S-102 on an S-100

compatible systems, and the demonstration of ENC (S-101/S-57) in S-100 navigation system for Dual Fuel along major shipping routes. The project IHO & IALA collaboration to demonstrate interoperability of S-101 and S-125 at sea successfully concluded in 2023.

Marine Spatial Data Infrastructure

30. MSDI has been highlighted as an important component of the future development of hydrographic offices. As there is either no, or very little, basic teaching material available for MSDI training that is free of charge for IHO Member States. IHO has established basic MSDI training material, in order for IHO Member States and the respective Regional Hydrographic Commission to conduct basic MSDI education/training. The MSDI training material is now freely available on the IHO web page under MSDIWG Body of Knowledge <https://iho.int/en/body-of-knowledge>. An MSDI e-learning program has also been developed to enable people to access MSDI teaching externally and even receive the teaching online. The MSDI teaching material is available on the IHO's website for free. The e-learning interactive material can be downloaded or used on YouTube.

31. The FAIR Data Principles (Findable, Accessible, Interoperable, Re-usable) are used widely in the geospatial community, promoting, and supporting knowledge discovery and innovation as well as data and knowledge integration, and sharing and reuse of data. The FAIR principles do not strictly define how to achieve a state of "FAIRness". Rather they describe a continuum of features, attributes, and behaviors that will move a digital resource closer to that goal. The principles help data and metadata to be 'machine-readable', supporting new discoveries through the harvest and analysis of multiple datasets. In order to have a Hydrographic Offices approach to the FAIR Data Principles IHO will establish guidelines on how IHO MS can use the FAIR principles in their work with their national and regional MSDI and together with the OGC MDW establish an MSDI FAIR principles checklist

32. The concept of Digital Twins is now widely used and in the marine community, the application as Digital Twin of the Ocean or Digital Twin of the Sea are now under development. Digital Twins provide a framework for creating a digital truth about the physical environment. Through simulations that show the cause and effect of an event happening, Digital Twins help policymakers and decision-makers make informed decisions to prevent incidents from occurring or mitigate the event's impacts. A digital twin should be seen as a digital replica of a living or non-living physical entity. By combining the physical and the virtual world, data is provided enabling the virtual entity to exist at the same time as the physical entity. As seen from a MSDI perspective this has to be an important component in marine Digital Twin applications. The MSDI will be able to provide the datasets in order to create a highly complex virtual model that is the exact counterpart (or twin) of a physical thing. The 'thing' could be for example a harbor, sailing route, marine protected area. Connected sensors on the physical asset collect data that can be mapped onto the virtual model. A marine digital twin will be a vital tool to help operators understand not only how products and initiatives are performing, but how they will perform in the future. Analysis of the data from the connected sensors, combined with other sources of marine information, will allow agencies to make predictions. In order to have a Hydrographic Office approach to the marine Digital Twins IHO will establish recommendations to IHO MS on how MSDI and HOs can be part of Digital Twins in the future.

33. Taking the development of the United Nations Integrated Geospatial Information Framework (UN-IGIF) and the Operational Framework for Integrated Marine Geospatial Information Management (UN-IGIF-Hydro) into consideration, it is important that there is better alignment and integration with UN-IGIF and UN-IGIF-Hydro as this will ensure a uniform approach to data management between land and sea. There are numerous common elements within UN-IGIF/UN-IGIF-Hydro and MSDI and simple connections could be made which would bring the definitions section up to date. As a consequence, IHO had a process for updating/modifying the IHO publication C-17 in response to the two IGIF initiatives. The focus of a new version of C-17 is on how Hydrographic Offices can act in

response to UN-IGIF and UN-IGIF-Hydro and the broader global perspective and will focus on some of the working issues, like data consistency, data quality, multiple-use best practices, business models, the FAIR principles, maritime digital twins etc. leaving IGIF and IGIF-Hydro to define broader use cases. The new Edition 3.0 of C-17 is available on IHO publication at <https://iho.int/en/capacity-building-publications>.

Global coverage of seabed topography

34. In order to improve the incomplete image of the ocean's seabed topography from all available data resources, IHO has continued to develop its "Crowdsourced Bathymetry campaign" and its supporting guidance document (IHO B-12). In addition, significant developments have been undertaken to the IHO's Data Centre for Digital Bathymetry (DCDB) to enhance uploading, data viewing and download functionality. The resulting General Bathymetric Chart of the Oceans (GEBCO) grid of global ocean seabed topography is publicly available under open data policy terms for download and re-use. The grid is now updated on an annual basis, having grown from 6% in 2017 to 24.9% in 2024.

V. Support to the implementation of the UN-IGIF

35. After the 3rd edition of the standards guide was endorsed at the Eleventh session of the Committee of Experts, the SDOs made it available as a web publication, open for continuous feedback.

VI. Geospatial standards in measuring and monitoring the SDGs

36. The SDOs continue to maintain and advance a framework of geospatial standards and good practices that support the mapping, visualization, analysis and forecasting related to the 17 SDGs topics. SDOs general purpose geospatial standards continue to be adopted by technology suppliers worldwide to make it easier for the user community to implement F.A.I.R. solutions that are broadly compatible for collaboration and data sharing. SDOs domain specific standards are helping to address specific SDG such as addressing hunger, health, and sustainable communities.

37. Some specific examples of SDOs support to SDGs over this past year include:

- (a) Goal 2 Zero Hunger: ISO/TC 211 Land Cover/Land Use;
- (b) Goal 3 Good Health and Well Being: OGC Health Spatial Data Infrastructure Data Model;
- (c) Goal 9 Industry, Innovation and Infrastructure: All SDOs general purpose standards apply;
- (d) Goal 11 Sustainable Cities and Communities: implementation of OGC CityGML, OGC Indoor Mapping Data Format Community Standard;
- (e) Goal 13 Climate Action: SDOs General Purpose Standards, OGC Open API: Environmental Data Retrieval; and
- (f) Goal 14 Life Below Water: IHO Electronic Navigational Chart, S-102 – Bathymetric Surface, S-111 – Surface Currents, and S-129 – Under Keel Clearance.

VII. Points for discussion

38. The Committee of Experts is invited to:

- a) Take note of the present report of the three standards development organizations and express its views on their work and contributions to the global geospatial information community;**
- b) Take note of and express its views on the numerous ongoing standards development activities including efforts to work with the United Nations Global Geodetic Centre of Excellence towards a sustainable ISO Geodetic Register.**
- c) Encourage Member States to set policy that starts with open standards as a default for geospatial and location information programmes, and the broad use of geospatial standards and the Standards Guide to support the implementation of standard-based solutions that ensure interoperability, data-sharing and flexibility to adapt to changing data sources and technologies; and**
- d) Encourage broader participation in the continued development, maintenance and advancement of geospatial standards in collaboration with the standards development organizations.**