

## IOC IODE-GOOS Data Workshop: Executive Summary

The IOC IODE-GOOS Data Workshop, held 30 September - 02 October 2024, focused on enhancing collaboration between the International Oceanographic Data and Information Exchange (IODE) and the Global Ocean Observing System (GOOS). The goal was to enhance coordination and discuss an integrated and scalable IOC digital architecture that would improve data sharing, management, and accessibility, across ocean systems, and enhance the IOC's support to key United Nations mandates.

Key objectives of the Workshop:

- **Identify roles and synergies:** Clarifying the mandates, responsibilities, and connections between GOOS and IODE, for all Essential Ocean Variables (EOVs).
- **Develop a joint vision for an IOC Data Architecture:** Establishing a co-evolved, integrated, FAIR and CARE aligned, IOC data architecture to support the ocean digital ecosystem.
- **Technical foundation:** Developing the technical architecture for a unified IOC Data space to be presented at the IOC Assembly in 2025.
- **Coordination:** Define coordination between GOOS and IODE to evolve and mature the IOC Data Architecture.
- **Future planning:** Outlining next steps (short and long term) for meeting future user needs.

### The joint vision for an IOC Data Architecture

The Workshop participants agreed on a basic schema for the IOC Data Architecture, linking key IOC components into a holistic ecosystem. Figure 1 illustrates this schema, which is further described in Box 1.

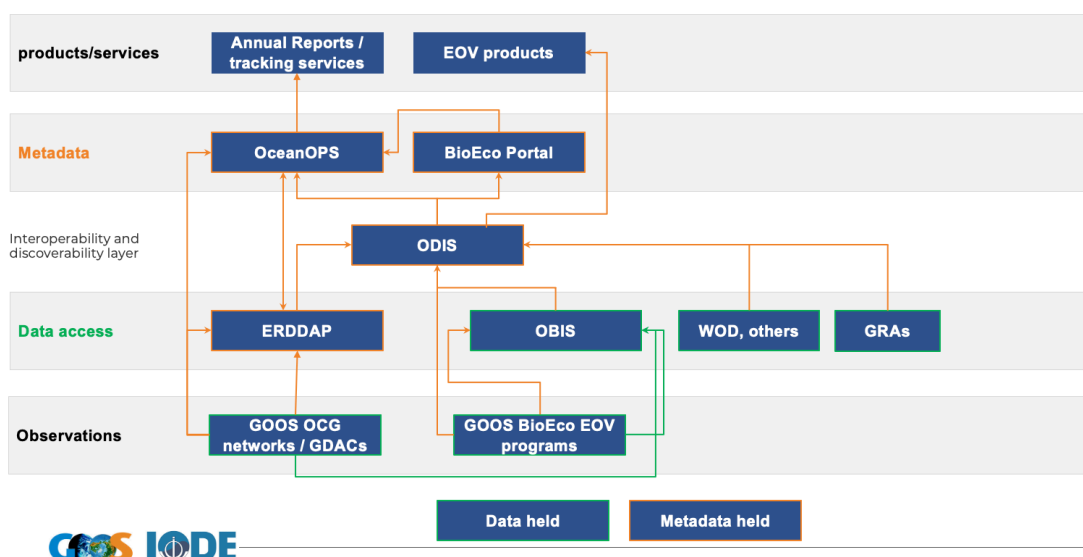


Figure 1: Schematic of the proposed IOC Data Architecture that will be developed further through the proposal. This schematic was adjusted from the Workshop Report to show the key IOC components. Key to acronyms: IODE Ocean Data Information System (ODIS), IODE Ocean Biodiversity Information System (OBIS), GOOS OceanOPS (WMO-IOC Joint Operational Centre Ocean Observing), ERDDAP™, World Ocean Database (WOD), GOOS Regional Alliances (GRAs), GOOS Observation Coordination Group (OCG), GOOS Ocean Observing Networks/Global Data Assembly Centres (networks/GDACs), GOOS Biological and Ecological EOVS Observing Communities (BioEco EOVS programmes)

Many elements of the proposed IOC Data Architecture already exist, however the workshop outlined an approach forward to optimise connections between existing elements, as well as clarification of support needed, that would strengthen delivery of ocean data for operational services. As a first step, the Workshop participants agreed to set up a working group to develop a proposal for the IOC Data Architecture for the IOC Assembly in June 2025. Key steps in the short and longer term are outlined in the Workshop Report, and summarised below.

For the short term, the workshop participants agreed to:

- Develop a proposal for the IOC Data Architecture that can be presented in draft form to the 14th GOOS Steering Committee in February 2025; the 28th IODE Committee Meeting Data Management in March 2025; and in final form to the 33rd IOC Assembly in Paris in June 2025
- Establish and start the work of the IOC Data Architecture Working Group to write a proposal for a cross IOC data architecture/space. This would include a number of aspects such as vision, structure, governance and resource needs. The Working Group will be supported by a jointly funded (IODE-GOOS) consultant, and initial activities include to:
  - Map the data flows - what to govern and what to implement - look at optimisation/eliminating redundancy
  - Create 'rules' of coordination, responsibilities - ODIS broker, services, data flows
  - Select showcase pilots that demonstrate data flows and the broker services, and test that assumptions regarding the architecture are robust
  - Set minimum metadata requirements, including provenance, licensing, EOVS data precision, and a semantic identifier for 'GOOS' EOVS data.
  - Develop a joint resource strategy and solicit feedback from key stakeholders to shape the IOC Data Architecture.

For the longer term, the workshop participants highlighted key aspects to consider in the planning for, and the implementation of, an IOC Data Architecture, including a phased plan and regular input from stakeholders, including to:

- Create a phased implementation plan that identifies goals and roles of different IOC groups, with clear regional support, including for SIDS.

- Establish a pathway to mature the IOC Data Architecture and its associated digital ecosystem into an IOC Data Space to support advanced data handling.
- Establish regular consultation and need/opportunity assessments with:
  - IOC Member States
  - IOC regional sub-commissions
  - Ministries for digital transformation and/or ocean-related affairs
  - Ad hoc groups, as required
  - IOC programmes (and their governing bodies)
- Create Minimal Viable Product(s) to support value demonstration and to test robustness and utility of the architecture.
- Implement a quality assessment framework to support certification of data quality and reporting of GOOS EOVs and SDG Indicators or related data.
- Support the maturation of digital culture for all those using or contributing to the IOC Data Architecture.
- Include, in the implementation plan, key metrics to address the digital divide and monitor and enable digital equity.
- Provide a phased plan that includes resource requirements for each phase, and related success markers.
- Undertake a review (2030), and check that IOC is:
  - Responding to operational needs for global initiatives
  - recognised as the trusted source for ocean data
  - enhancing NODC capacity where needed, and successfully entraining new ocean data (e.g. from private sector)

The Workshop Report contains a detailed description of the existing infrastructure elements, the ideas and planning suggested towards an IOC Data Architecture, and a list of actions. The workshop can thus provide the basis for the planning and development of the ***IOC Data Architecture***.

### **Box 1: IOC Data Architecture - technical concept and function**

#### **Core ideas:**

- Based upon concepts which have shown great utility in both GOOS and IODE: open and modular technology, distributed-yet-federated system designs, metadata-driven exchange and orchestration, and an interoperability-first approach to data management and system engineering
- Based on, and extending, the IODE Ocean Data Information System (ODIS) Architecture, which federates digital asset catalogues from over 50 data sources (including continental-scale data hubs)
- Providing consistent implementation of the FAIR and CARE Principles, with alignment to the UN Ocean Decade Data and Information Strategy and its Implementation Plan
- Assess and preserve data provenance and lineage metadata, allowing derivative data products to be traced back to the point of truth (e.g. observations or models)

- Recognising that the GOOS EOVs are an essential element within this architecture

***Function and attributes:***

- Serve as the foundation of global ocean data sharing, powering global solutions and the IOC mission
- Support global services and data products - available to all - to detect, consolidate, and deliver GOOS-certified EOV data of documented quality
- Coordinate data and information across the IOC value chain to support operational services
- Deliver data about or supporting EOVs, SDG indicators, and other artefacts into global assessment and multilateral processes
- Provide IOC with a clearly defined, unique niche in the ocean digital ecosystem for more efficient investment
- Interface - at scale - IOC's core digital capacities with other existing architectures and infrastructures (e.g. WMO's WIS 2.0, UNEP's WESR)
- Bridge digital divides and help mature digital ecosystems globally through digital capacity transfer

***Technical building blocks:***

- Central ERDDAP™ servers operated by GOOS OCG will consolidate ocean observing data, including EOV data, from across global or thematic ocean observing networks. The GOOS ERDDAP™ server will then become an ODIS "Hypernode" (a node which, itself, contains a network of other nodes, in this case observing network ERDDAPs - OCG Data Implementation Strategy).
- OceanOPS, the IOC-WMO Operational Centre, will link its operational metadata - describing the state of the global ocean observing system - to ODIS and/or the GOOS Hypernode, while also enriching its services
- The IODE Ocean Biodiversity Information System (OBIS) - already an ODIS Node - will establish mechanisms to detect, identify, validate, and relay (meta)data relevant to GOOS BioEco EOVs, becoming a GDAC for BioEco EOVs
- Leveraging the capacity of the envisioned IOC architecture, the GOOS BioEco Portal will enhance its current mapping of biological and ecological observing networks with EOV (meta)data streams gathered from the GOOS Hypernode and all other ODIS Nodes.
- GOOS and/or other IOC activities focused on delivering curated EOV based services (such as the biogeochemical EOV focused Global Ocean Data Analysis Project; GLODAP) will explore how to build and maintain services and portals (similar in nature to the BioEco Portal) using the new capabilities provided through the IOC Data Architecture.

***Enabling connectivity, inclusivity and supporting delivery:***

- Using GOOS EOVs (and ECVs, where relevant), ensuring semantic identifiers and provenance, and connecting key elements across GOOS and IODE (as seen in Figure 1: OBIS, OCG ERDDAP™, OceanOPS, BioEco Portal, EOV Portals and services) through the ODIS Architecture, (meta)data can more easily flow across disciplines, such that they can become globally FAIR
- Secure and preserve provenance, conformance, and quality metadata, to ensure downstream products can be traced back to their raw components for validation and auditing, and be (re)used with confidence
- Expand the discoverability of EOV (meta)data across all ODIS Nodes, to support GOOS in extending its coverage
- Support IOC programmes in efficiently harvesting data from all sources to create products with known provenance, and in the establishment of ODIS nodes
- Co-implement CARE-aligned technologies and practices to recognize, respect and engage local and Indigenous knowledge holders



Figure 2: Workshop participants