OCEAN ENTERPRISE INITIATIVE

Standards Dialogue Synthesis

What Standards are Needed to Accelerate the Ocean Enterprise?

Workshop at Oceanology International, London. March 2024

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I. Dialogue Purpose

The Marine Technology Society (MTS), the Global Ocean Observing System (GOOS), and the National Oceanic and Atmospheric Administration (NOAA), in collaboration with industry partners Kongsberg Discovery and L3Harris have launched the Ocean Enterprise Initiative. This was based on the successful *Dialogues with Industry* series, which involved consultations with stakeholders in the Ocean Enterprise. The Dialogue with Industry Roadmap (hereafter Roadmap) emphasizes an integrated approach that enhances all facets of the Ocean Enterprise along the Ocean Information Value Chain.

An integral aspect of the *Dialogues with Industry* Series is its focus on a cohesive set of prioritized action pathways that bolster every aspect of the Ocean Enterprise, rather than isolated initiatives. To guide these efforts, three interdependent goals have been defined:

1. Establishing a robust Ocean Enterprise recognized as essential to lives and livelihoods.
2. Enhancing the visibility of the Ocean Enterprise as a significant contributor to the global Gross Domestic Product (GDP).
3. Identifying the ocean observing, products, and services sector as a distinct market sector attracting investment.

Recognizing the importance of "Collaboration to Grow and Impact Change" and "Improving the Marketplace" priority areas from the *Dialogues with Industry* Roadmap, MTS, GOOS, NOAA, Kongsberg Discovery, and L3Harris co-hosted strategic dialogues at Oceanology International (Oi). These dialogues focused on two areas to maturing the Ocean Enterprise: Standards and Marine Carbon Dioxide Removal (mCDR). By addressing both standards and market development, these strategic dialogues exemplify the power of collaboration in propelling the Ocean Enterprise forward.

What Standards are Needed to Accelerate the Ocean Enterprise?

The lack of standardized practices has been identified as a major hurdle for private sector engagement. To address this, the Standards dialogue at Oi focused on "Collaboration to Grow and Impact Change" by facilitating discussions around:

- Motivations and incentives for the oceanographic community to adopt standards.
- Specific standards that can significantly advance the Ocean Enterprise.

II. Standards Dialogue

Within the *Dialogues with Industry* series, the topic of ocean observing standards[1] took center stage. Participants highlighted the pivotal role that standards play in shaping commercial growth, emphasizing their potential to level the playing field and mitigate investment risks. However, amidst these discussions emerged pressing questions: What precisely constitutes effective standardization, and where do opportunities for progress lie?

The dialogue was led by 4 experts in the ocean enterprise and attended by 19 representatives across academia, government, non-governmental organizations, and private industry (Appendix 4). Discussions highlighted that standards span a broad spectrum, encompassing specifications, codes of practice, methods, and guides. Moreover, the application of standards extends across diverse sectors, from information technology to devices, equipment, and infrastructure such as cables, connectors, communication protocols, autonomy, and data management systems.

This dialogue elevated the diverse challenges associated with standards within the marine technology sector, with a need to delve into the specifics. Some of the specific questions discussed included:

- Which standards are most conducive to industry's needs?
- What hurdles do you encounter in adopting and enforcing standards?
- What concrete steps can be taken to propel standardization efforts forward?

This session served as a pivotal platform for dialogue, bridging the Ocean Enterprise community with relevant standardization bodies. This dialogue offered a vital opportunity for industry-focused discussions to elucidate the essential standards, discern actionable pathways, and drive tangible progress in advancing standards that underpin industry growth and resilience.

III. Background and Overview

Zdenka Willis (MTS Past President) and **Donna Kocak** (L3Harris Technologies) provided the context and background. The lack of consistent standards presents challenges for both private and public sectors, as it hampers the establishment of shared data and instrumentation targets, and the ability to hold private sector providers accountable for their delivery. While standards have the potential to create a level playing field for competition and ensure data accessibility, there is a delicate balance to strike to prevent stifling innovation. Moreover, the specificity of standards may need to vary based on factors such as the intended use (i.e., climate applications, informing development, etc.) and the environmental context (e.g., open ocean vs. coast).

1 Definitions provided in Appendix 3.

Ms. Kocak discussed the key takeaways within the *Dialogues with Industry* Roadmap, highlighting the urgency of addressing the absence of standards as a barrier to accelerating progress within the Ocean Enterprise. This includes recognizing the interdependence of ocean observing and services within the market, articulating market size to attract investment, and overcoming funding challenges. Standards are envisaged to enhance communication and align stakeholders but also as a catalyst for market advancement and increased investment in products. However, their effectiveness hinges on enforcement and simplicity, with a clear linkage to markets and procurement processes.

The dialogue underscores the importance of thoroughly understanding existing practices and gaps to make a meaningful impact. While the goal of implementing standards is clear, the pathway to achieving it requires careful consideration of the landscape and identifying strategic areas where intervention can yield lasting results. By fostering collaboration and streamlining efforts, the initiative aims to pave the way for a more standardized and cohesive Ocean Enterprise, ensuring its resilience and effectiveness in addressing pressing ocean observation and services challenges.

IV. Breakout Sessions

Observation Technology

Expert Moderator: Donna Kocak (L3Harris Technologies)

The "Observation Technology" breakout discussions centered on the need for generic, interoperable solutions in observation technology and ocean observing. Bristlemouth emphasized the importance of modularity and interoperability across platforms, highlighting the limitations of proprietary frameworks and the resulting siloing effect. Participants stressed the necessity of increased collaboration through demos, testbeds, and meetings to break down these silos. Key points included:

- **Standards and Metrics:** There was a focus on developing standards for instruments, including metrics, classification, and specifications tailored to different environments and depths. Participants discussed the potential adoption of existing templates from other sectors to inform ocean observing standards.
- **Utilizing Case Examples:** The importance of open use case examples accessible to the public was highlighted, serving as models for best practices in observation technology.
- **Data Collection and Quality:** Agreement on standards for data quality and protocols for data collection and dissemination were deemed essential for effective observation technology.
- **Plug and Play Interface:** Participants discussed the need for a common interface that allows any sensor to interact with a main control hub, facilitating seamless integration and operation.

- **Software Language:** There was a call for developing interfaces capable of understanding various connectors, autonomous underwater vehicles (AUVs), and sensors to enhance compatibility and ease of use.
- **Collaborative Test Beds:** The establishment of collaborative test beds was suggested to facilitate experimentation and validation of observation technology solutions.
- **Offshore Environment Standards:** Concerns were raised regarding the lack of standards specific to offshore environments to deploy rigs for energy production. Participants highlighted the need for dynamic standards to address offshore operations' challenges effectively.

The session underscored the importance of collaboration, standardization, and innovation in advancing observation technology, particularly in ocean monitoring and exploration.

Sensors & Observations

Expert Moderator: Fraser Dalgleish (L3Harris Technologies)

In the "Sensors & Observations" breakout session, participants discussed the effective grouping of organizations across the value chain in the context of observations and sensors. Key points from the session included:

- **Overlap in Groupings:** Participants noted more overlap than clear distinctions in the groupings of organizations involved in observations and sensors. This led to discussions on better categorizing and collaborating across the value chain.
- **Calibration and Metadata:** The importance of calibration standards and metadata for hardware and software was emphasized, as they are essential for making data usable and ensuring quality control.
- **Existing Programs and Standards:** The Argo program was highlighted as a successful example of a global initiative with standardized data that is publicly available and quality controlled. Discussions also touched upon existing metadata standards, such as those defined by International Standards Organization (ISO) and the European Union.
- **Data Accessibility and Usability:** Concerns were raised about making ocean data more usable, with comparisons drawn to the weather enterprise where data is treated as a product. Participants discussed the challenges of transforming data when sensors are updated and the need for workforce development to support data management and standardization efforts.
- **Next Steps and Solutions:** Proposed solutions included examining successful programs like Argo for insights into sampling methods and data quality standards, creating cross-knowledge communication channels, and focusing on critical standards such as

Open Geospatial Consortium's (OGC) Environmental Data Retrieval (EDR) and ISO for Metadata.

- **Gap in Metadata Standardization:** It was noted that metadata standardization is a significant gap in the field, with efforts needed to address this issue for improved data interoperability and usability.

Overall, the session highlighted the importance of collaboration, standardization, and data accessibility in advancing sensor technologies and observational practices, focusing on leveraging successful programs and implementing essential standards to enhance data quality and usability.

Data and Information Delivery

Expert Moderator: Mario Miranda (Lockheed Martin)

In the "Data and Info Delivery" breakout session, participants discussed data formats, protocols, and delivery methods in ocean observation. Key points from the session included:

- **Diverse Formats and Protocols:** Participants highlighted the plethora of formats and protocols used across different logger systems, which pose challenges to data interoperability and real-time access. Compression techniques were discussed as crucial for efficient data transmission, given the increasing demand for real-time data access.
- **Challenges in Data Interpretation:** The need for humans or machines to extrapolate and interpret data was noted as a significant challenge due to the lack of standardized structures and nomenclature.
- **Variety in Data Delivery Pathways:** Data delivery pathways were identified as comprising three primary stages: from sensor to logger, from logger to shore, and the format of the end deliverable. Challenges arise when hardware constraints or client preferences dictate formats.
- **Importance of Standardization:** Participants emphasized the importance of standardization in addressing these challenges, suggesting that adoption by international bodies such as the Integrated Ocean Observing System (IOOS) and GOOS could facilitate the process. While the lack of standardization is identified as hampering growth there is to implement the standards therefore the private sector wants assurances that these standards will be included in request for proposals.
- **Adaptable Standards Framework:** Suggestions were made for developing an adaptable standards framework that identifies best practices for each stage of data delivery. Additionally, a conversion system or "universal translator" capable of reconstructing data into a consistent format was proposed, leveraging metadata, and potentially employing machine learning algorithms.

- **Dynamic Nature of Technology:** The rapid progression in technology was recognized as a complicated factor, with the need to balance standardization efforts with the ever-evolving landscape of technological advancements.

Key takeaways from this breakout session included the identification of different format types, the importance of plug-and-play standards, and the need for a comprehensive understanding of available metadata. Participants emphasized the importance of collaboration within the IOOS community and the potential for innovative solutions to bridge existing data delivery and standardization gaps.

V. Primary Themes

The Standards Dialogue session served as a platform to address the absence of standardized practices within the Ocean Enterprise. Participants highlighted the critical need for collaboration, standardization, and innovation to drive progress and ensure industry growth and resilience. By identifying challenges and opportunities, the session laid the groundwork for concerted efforts to advance standards within the marine technology sector.

Need for Standards

- Participants underscored the indispensable role of standards in facilitating commercial growth within the Ocean Enterprise. Standards were acknowledged as pivotal in leveling the competitive field and reducing investment risks.
- There was a consensus that standardized practices are essential for ensuring product quality, interoperability, and accountability within the industry.

Complexity of Standards

- The session illuminated standards' multifaceted nature, encompassing specifications, codes, regulations, methodologies, and best practices. These standards extend across diverse realms, including information technology, devices, equipment, and infrastructure.
- It was recognized that the application of standards varies depending on factors such as intended use (e.g., climate applications vs. weather) and environmental context (e.g., open ocean vs. coast).

Challenges and Opportunities

- Discussions surfaced various challenges impeding standardization efforts, including interoperability issues, data quality concerns, and the absence of standardized structures.
- GOOS, a convener of this workshop and a key player in the Ocean Enterprise Initiative has the authority to request standards for the observing system. There is a chance to

leverage this authority to gain momentum for developing new standards and build acceptance and adoption of them.

Breakout Sessions Highlights

- **Observation Technology:** Emphasis was placed on the need for generic, interoperable solutions in observation technology, with discussions revolving around standards development for instruments, metrics, and classification. Collaboration and innovation were highlighted as crucial for breaking down silos and fostering progress in the sector.
- **Sensors & Observations:** Participants discussed the importance of calibration standards and metadata in ensuring data usability and quality control. Successful programs like Argo were cited as examples, emphasizing the need for metadata standardization and workforce development to support standardization efforts.
- **Data and Information Delivery:** Challenges in format and protocol diversity were identified, with participants emphasizing standardization's importance in addressing these challenges. Suggestions included the development of adaptable frameworks and universal translators to enhance data interoperability and usability.

VI. Identification of Challenges and Next Steps

The workshop participants highlighted several challenges in improving standards across the ocean enterprise. This included the need for a closer alignment with use cases, the prioritization of initiatives, and fostering active participation in the development and conversation around these standards. Other challenges included spreading awareness about these initiatives and the formation of effective working groups.

The participants believe that the primary drivers to evaluate improvements should include added credibility, trust in the data, a significant number of stakeholders contributing to the effort, and a count of how many are going through the accreditation process. Other markers of improvement include receiving reliable data over the long term, market growth, simplification and cost reduction, sensors outputting to the standards, alignment with GOOS initiatives, increased data availability, positive feedback from users, the development of innovative products, and widespread adoption of these standards.

Moving forward, participants suggested several next steps to continue the momentum gathered during this initial workshop (Appendix 5):

1. GOOS has the authority, even if only implied authority, to request standards and should take a leading role.
2. Involve regional facilitators, professional networks, and existing players in space, such as the Bristlemouth Forum.

3. Adopt a use case-focused lens that ensures all standardization efforts address real industry needs.
4. Promote and highlight successful standards to increase adoption and visibility.
5. Gather inspiration from existing standards such as IOGP, IMCA, UMAA, IHO s44, wave data statistics standards, and ISO Metadata standards as potential models or resources.

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Thank you for your continued support, interest, and commitment to making the pathways effective and impactful across private, government, and science. We look forward to your participation in the Dialogues as they continue.

Appendix 1: Dialogue Materials

- Presentation Slides
- *Dialogues With Industry* Roadmap

Appendix 2: Dialogue Agenda

Time	Agenda Item
11:30 AM - 11:40 AM	Welcome & Introduction
11:40 AM – 12:10 PM	Existing Standards within the Ocean Value Chain
12:10 PM – 12:35 PM	Breakout Groups: Standards Gaps and Improvement Areas • Observing Technology • Observations & Sensors • Data & Information Delivery
12:35 PM – 12:55 PM	Outlook and Interest in Advancing Standards
1:00 PM	Adjourn

Appendix 3: Definitions

- **Standards:** Generally voluntary guidelines or specifications established by consensus to ensure products, processes, or services meet certain criteria. They provide a common framework for consistency and interoperability but are not necessarily legally binding.
- **Codes:** Typically legally enforceable requirements established by governments or regulatory bodies. They specify minimum standards that must be met for construction, safety, or other purposes, often with the aim of protecting public health, safety, and welfare.
- **Regulations:** Rules or laws mandated by governmental authorities that dictate specific requirements or restrictions within a particular industry or jurisdiction. They are legally binding and must be adhered to by individuals, organizations, or businesses.
- **Methodologies:** Systematic approaches or frameworks used to accomplish tasks, solve problems, or achieve goals. They provide structured guidelines for conducting activities or processes, often based on established principles or best practices within a specific field.
- **Best Practices:** Proven techniques, strategies, or methods that are recognized as being effective and efficient in achieving desired outcomes. They represent the collective wisdom and experience of practitioners within a particular industry or domain and are often used as benchmarks for performance or quality.

Appendix 4: Participant & Speaker Directory

Speakers

Name	Title	Affiliation
Mario Miranda	Staff Systems Engineer, Undersea and Autonomous Systems	Lockheed Martin
Fraser Dalgleish	Senior Scientist	L3Harris Technologies
Donna Kocak	Fellow and Strategic Initiative Lead, Innovation Office	L3Harris Technologies
Zdenka Willis	Past President	Marine Technology Society

Participants

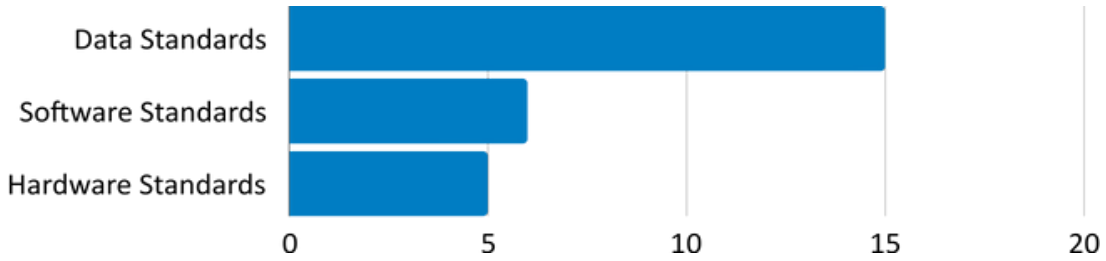
Name	Affiliation	Sector
Roger Proctor	Tidetech	Private
Jochen Klinke	Sea-Bird Scientific	Private
Zack Johnson	Sofar Ocean / Bristlemouth	Private
Mario Miranda	Lockheed Martin	Private
Fraser Dalgleish	L3Harris Technologies	Private
Barbara Loya	L3Harris Technologies	Private
Kristyn Keefe	Sea-Bird Scientific	Private
Virginia Van Dongen-Vogels	European Global Ocean Observing System	Intergovernmental
Ashley Roseworthy	Edgewise Environmental	Private

Name	Affiliation	Sector
Garry Glass	Kings College London	Academia
Rob Smith	Collecte Localisation Satellites-Woods Hole Group	Academia
Caroline Levey	OceanWise	Non-Profit
Anna Savage	Scripps Institute of Oceanography: Multiscale Ocean Dynamics	Academia
Patriche Gorringe	Swedish Meteorological and Hydrological Institute	Governmental
Jessica Sandoval	Deep Ocean Observing Strategy, AguaVela	Private
Emilie Breviere	Swedish Meteorological and Hydrological Institute	Governmental
Robin Sielken	TransMartech Schleswig-Holstein GmbH	Private
Florian Klabes	TransMartech Schleswig-Holstein GmbH	Private
Julia Poyelle	RTÉ	Public

Appendix 5: Slido Results

Throughout the discussions, Slido software was utilized to gather participant feedback, facilitating group conversation. Feedback gathered from this tool is provided below.

What types of standards are most needed at this time?



Are there other groups of standards that we could work on that would have an impact across the value chain?

- Climate- feeding into MRV
- Calibration standards for intercompatibility
- Publication standards? Towards a hub for collecting and publishing standardization 'news'
- Confidence metric for data from low-cost sensors
- Loads!!
- Standards of standards
- CDR efforts measuring
- OGC in the data standards area
- Multi disciplinary standards

What do you want from standards?

- Accessibility
- Ensure that they align with enforceable codes and regulations
- Simplicity
- Traceability
- Better data
- Consistency (x2)
- Easiness to access
- Understandable
- Clarity
- Guidelines
- Interoperability
- Less product proliferation
- Easy to implement
- Velocity

Please elaborate on your most important need related to standards.

- Metadata
- Metadata standards
- Efficiency of information transfer
- Front-end data for usage in discussions, product application or derived services
- Where do I start?
- Intercomparison
- Data interoperability
- Environmental data: biodiversity metrics, acoustic data
- Quality control
- Too many standards currently exist
- Underwater communication
- Interoperability

What are the gaps in standards?

- Metadata from sensors ready to aid FAIR data
- Clarity on difference between standards, recommendations, best practices, etc.
- Too many to mention. Start off looking where strong standards exist already.
- Understanding what you want to standardize vs make a best practice
- Jurisdictional component. Different standards across borders.
- Naming convention for metadata (see Argo)
- Enabler standards identified
- Knowledge of existing standards in other sectors that could be transferable
- Where do I start?!

What should the primary drivers be to evaluate that we have made improvements?

- Credibility added
- Enabling trust in the data
- Being able to show that a significant number of Ocean Enterprise stakeholders contribute to this discussion/effort
- Count of how many are going through accreditation process
- Receive reliable data for long term
- Market growth
- Simplification, cost reduction
- Are sensors outputting to the standards?
- Does it work for GOOS initiatives?
- More data available
- Positive feedback from users
- New innovative products
- Adoption

What are your priorities moving forward?

- Simplify or even enable product comparisons
- Comparability
- To standardize how we design, integrate and operate real-time systems
- Understand provenance
- Ensure that standards are not restricting
- Lower barriers to entry
- Reduce inefficiency, more observations
- Enable faster progress
- Reliability in products
- Foster innovation
- Make life easier
- Receive reliable data for long term use
- Simplification
- Reduce discussions with customers
- Harmonization
- Would make ingesting data easier

What are you willing to do to help get there?

- If it gets closer to use case
- Support these initiatives
- Priorities as to what we do first
- Aid prototyping
- Taking action on development
- Be part of the conversation
- Forming working groups that's good
- Seabird is actively working with Argo on metadata standards
- Spread the word about this initiative!
- More workshops

Any other suggestions for next steps?

- It's important to always focus on 'what the value of a specific standard' will be. Can this be quantified? No standards for the sake of standardizing, please!
- Involving regional facilitators
- Use case focused lens
- Promote and highlight standards when set
- IOGP
- Visibility to current standards out there
- IMCA
- UMAA
- IHO s44
- Wave data statistics standards.
- ISO Metadata standards
- Join the Bristlemouth form! 😊
- OGC Environmental Data Retrieval

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