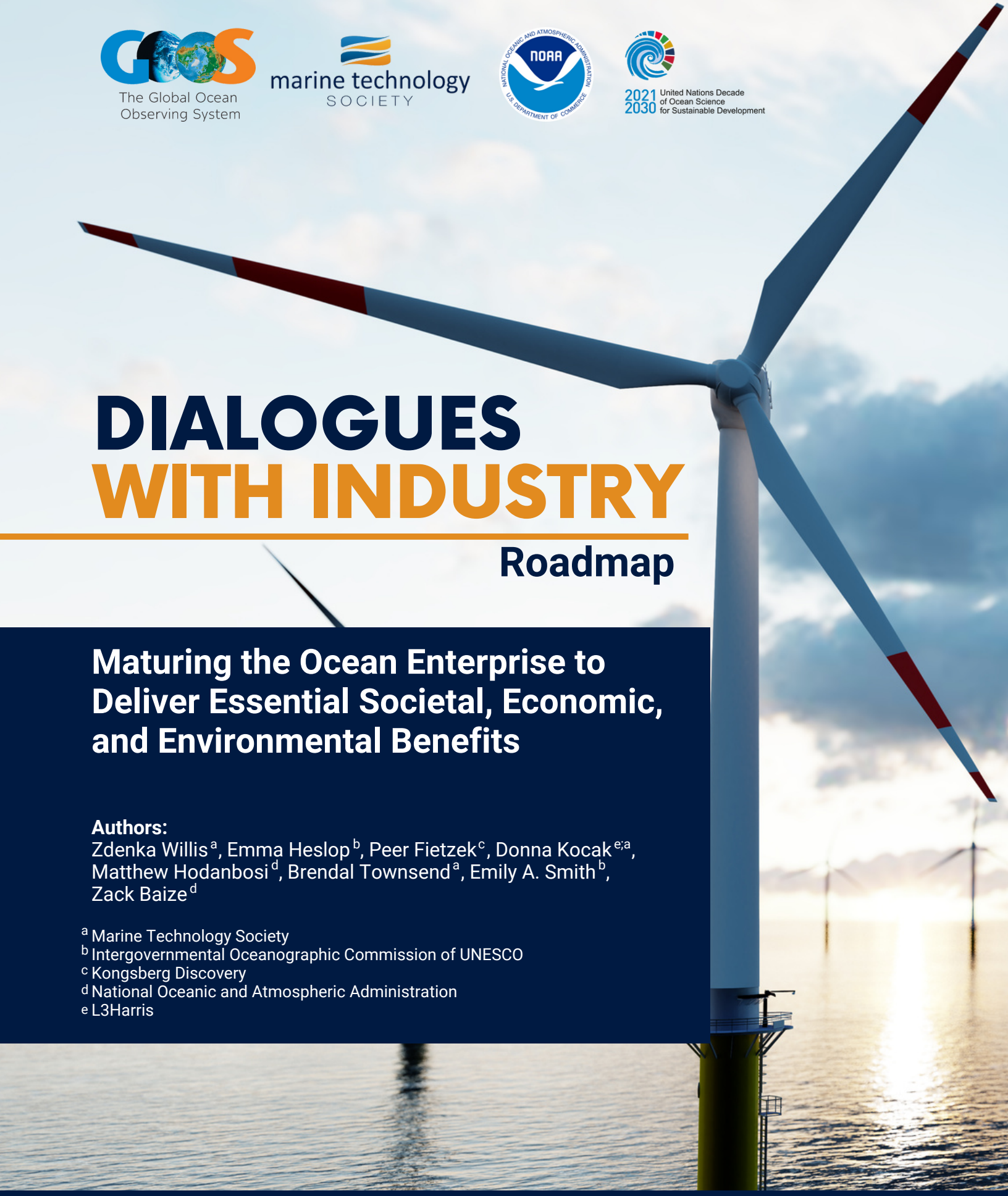
The Global Ocean Observing System

marine technology SOCIETY

2021 2030 United Nations Decade of Ocean Science for Sustainable Development



DIALOGUES WITH INDUSTRY

Roadmap

Maturing the Ocean Enterprise to Deliver Essential Societal, Economic, and Environmental Benefits

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Executive Summary

The *Dialogues with Industry* Roadmap (here after "Roadmap") builds on the proposed potential pathways identified through the series of consultations the Ocean Enterprise. and outlined in the *Dialogues with Industry* Synthesis Report and subsequent consultations. An important feature of the *Dialogues with Industry* series is its focus on an integrated set of actions that will enhance all components of the Ocean Enterprise across the Ocean Information Value Chain, as compared to focusing on individual actions. This Roadmap outlines a prioritized set of action pathways.

This initiative has been focused on understanding how to mature the Ocean Enterprise and based on the effort to date, the authors have defined three interdependent goals to guide our efforts going forward:

- A robust Ocean Enterprise recognized as essential to lives and livelihoods; ocean knowledge, products, and services are no longer considered peripheral.
- The Ocean Enterprise is visible, identifiable, and recognized as a strong contributor to the global Gross Domestic Product (GDP).
- The ocean observing, products and services sector is identified as a distinct market sector that attracts investment.

To achieve these goals, the *Dialogues with Industry* Roadmap is dedicated to advancing the following priority areas:

- Improving the Marketplace
- Collaboration to Grow and Impact Change
- Shaping the Future

The Roadmap was created by a group of representatives from Marine Technology Society (MTS), the Global Ocean Observing System (GOOS), and the National Oceanic and Atmospheric Administration (NOAA), along with industry experts (see authors list). The group analyzed 44 potential pathways, identified in the Synthesis Report and through subsequent consultations. Based on their feasibility and impact, the authors ranked the potential pathways and identified 26 as high-priority action pathways. These high-priority action pathways are grouped under the three priority areas listed above and shown in **Figure 1**.

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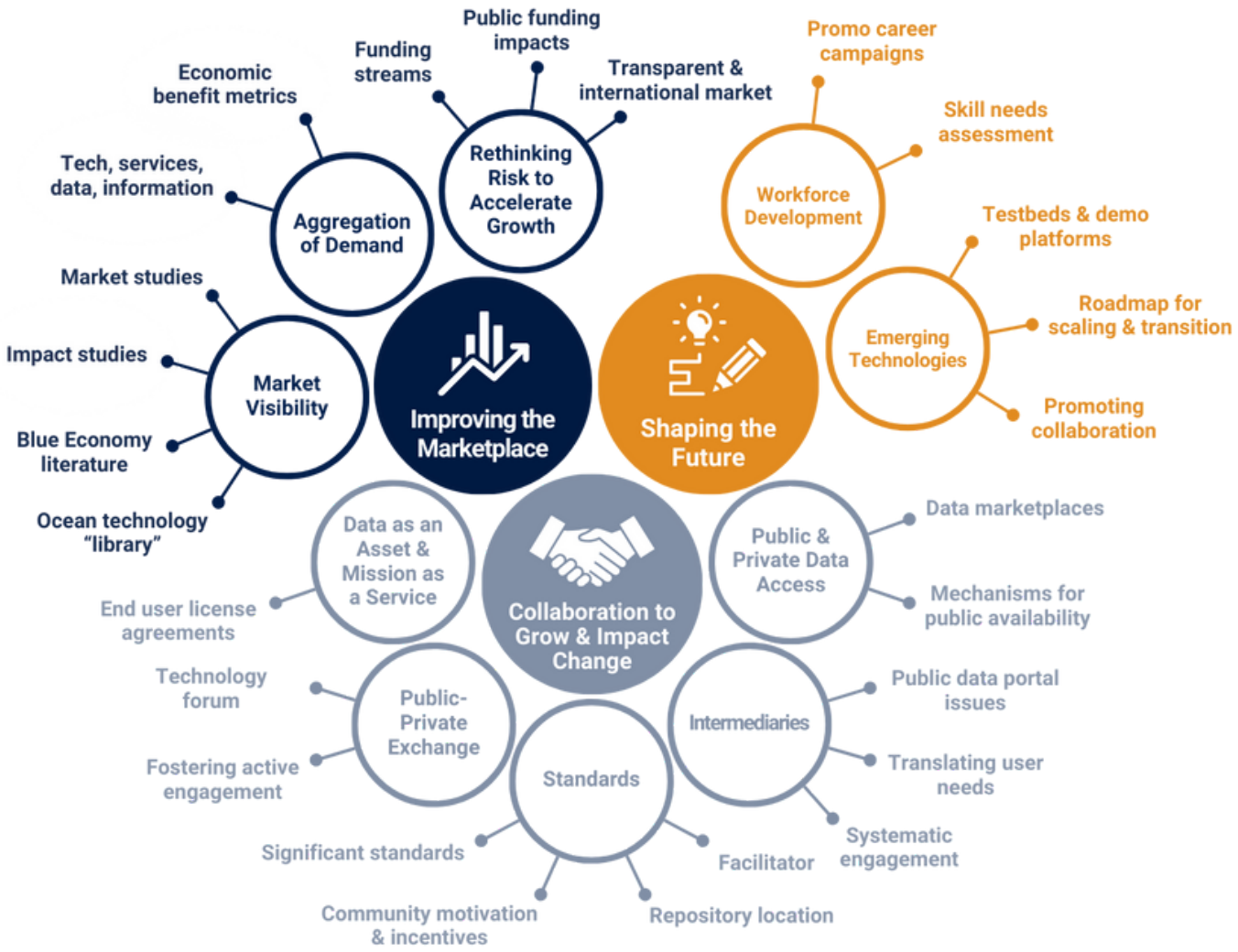

Figure 1. *This graphic highlights the 26 high-priority action pathways. These high-priority action pathways are identified with the challenges they are addressing and associated with the three priority areas: Improving the Marketplace, Collaboration to Grow and Impact Change, and Shaping the Future.*

The Roadmap was created to strengthen the Ocean Enterprise by inviting participation and input from people, companies, and institutions within industry. It aims to motivate stakeholders to have a say in who and what entities are best suited to carry out the necessary action pathways going forward. The authors identified potential partners in the linkage's sections, with a bias towards those that the authors are aware of, this is however not an exhaustive list. The aim is to show that collaborative and complementary action will drive the change we seek. Other potential partners are welcome and are encouraged to reach out. By working together as an enterprise, our collective voices will have more influence on the trajectory of the Ocean Enterprise and Blue investment.

For more information on the *Dialogues with Industry*, please visit the MTS and GOOS websites.

I. About the *Dialogues with Industry*

The Dialogues with Industry, a flagship series of four dialogues, was a joint initiative led by the MTS, GOOS and NOAA, and industry partners. It was the first international forum of its kind that brought together representatives from new and established companies, academic institutions, and government agencies to discuss the opportunities and challenges across the entire Ocean Information Value Chain, which is essential to achieving the goal of a mature Ocean Enterprise.

The term **"Ocean Enterprise"** refers to the entities and activities involved in ocean observation, measurement, and forecasting. The "Ocean Information Value Chain" is a conceptual framework that outlines the transformation of ocean observations into products and services that deliver information to decision-makers. The framework comprises several components that interconnect to deliver information to end-users, who in turn derive benefits from these information products.

OCEAN ENTERPRISE

Entities:

- **Public:** National, state, local, and tribal governments, as well as other public entities
- **Private:** For-profit companies, not-for-profit organizations, and non-governmental organizations
- **Academic**: Universities and research institutions

Activities:

- Infrastructure and capacity for ocean observation
- Measurement
- Forecasting
- Delivering operational ocean information services

Private and public organizations, as well as public-private partnerships at local, national, regional, and global levels, can contribute to any number of these elements according to the nature of their organization (i.e., through commercial products, public services, data collection and provision, and philanthropy.) Innovation and business opportunities are required within all these elements. A return on investment can be gained both within and across components.

The *Dialogues with Industry* effort was distinct from other industry engagement efforts because it brought together the components of the Ocean Enterprise with facilitated discussions across the Ocean Information Value Chain, depicted in **Figure 2**. The four Dialogues aimed to focus on the main components of the Ocean Information Value Chain, namely (1) Instrument Provisioning, (2) Multi-Sectoral Ocean Architecture, (3) User Driven Ocean Information Services, and (4) Looking Ahead.

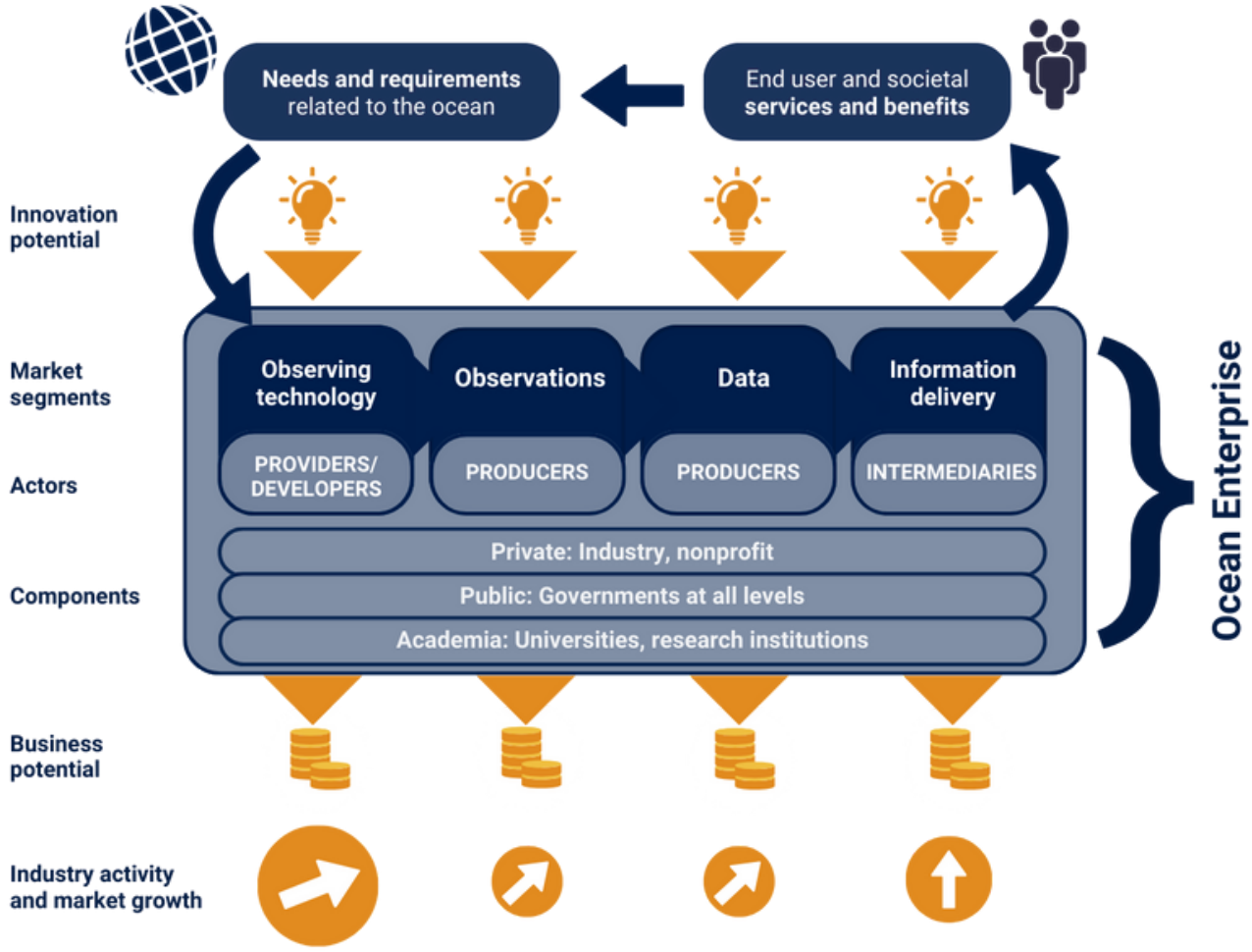

Figure 2: *This graphic visualizes the Ocean Enterprise and its interconnected components and activities across the Ocean Information Value Chain. The orange discs visualize the current level of private industry involvement in the segment, i.e. they offer an estimate of the current relative market size. The arrows indicate our estimate of private industry growth potential in each area (vertical is high). All market segments can benefit from innovation and can be commercially exploited.*

The Ocean Enterprise provides essential products and services that support the Blue Economy, including maritime transportation, shipping/ports, offshore energy, fishery and aquaculture, coastal tourism, security, and others. It plays a key role in providing the data and information to underpin sustainable development of ocean resources by fostering innovation, collaboration, and capacity building in the ocean domain. It is also vital for adapting to climate change, managing, tracking, and preserving biodiversity, and hazard warnings and response.

Maturing the Ocean Enterprise focuses on building new models that involve the public, private, and academic sectors providing a co-designed and co-operated sustained, robust ocean observing infrastructure and services to meet end-user needs.

II. Roadmap Development and Structure

The Roadmap was developed at the strategic implementation level and depends on collaboration across the Ocean Enterprise for success. It delineates specific recommendations for the high-priority action pathways that will enhance the value proposition of ocean data products/services, improve access to funding sources, foster innovation in emerging areas, strengthen collaboration among public-private entities, increase capacity building, and enhance the overall sustainability of the Ocean Enterprise.

Development

The Roadmap was developed through the following steps:

- Review of the *Dialogues with Industry* Synthesis Report, April 2023, and consultations with Ocean Enterprise stakeholders at OCEAN Business 2023 in Southampton, 23rd meeting of the United Nations -open ended Informal Consultative Process on Oceans and the Law of the Sea in New York (June 6, 2023), and through a dedicated side event at the Thirty Second Intergovernmental Oceanographic Commission (IOC) of UNESCO Assembly 2023 Paris (June 26, 2023).

- Evaluation of the 44 potential pathways extracted from the synthesis report, the session reports, and the feedback sessions to address the challenges and opportunities in the Ocean Enterprise by the *Dialogues with Industry* organizing committee core members (authors list) a group of representatives from MTS, GOOS, NOAA, and industry.

- Refining, categorizing, and assessing the identified pathways based on their ease of implementation, level of impact, and resulting overall priority.

- Grouping the high-priority action pathways under the three priority areas: Improving the Marketplace, Collaboration to Grow and Impact Change and Shaping the Future.

- Remapping of the categories from the *Dialogues with Industry* Synthesis Report into challenges.

Structure

Section three of the Roadmap links the high-priority action pathways to the challenges and priority areas. As reference, Appendix 1 has all 44 pathways against priority levels (high, medium, and low).

The priority areas begin with an introduction to the importance of the priority area and plans on how to move this area forward.

The tables present the challenge areas within the priority area and include the following:

- **Challenge:** Elaborates on the ocean challenge.
- **Success Indicators:** Defines key indicators to evaluate success.
- **Action Pathways:** Suggested actions to move ahead.
- **Linkages to other Initiatives:** Identifies a high-level overview of existing activities and initiatives to identify potential synergies. This is important as this effort is not about starting new efforts but rather coalescing the Ocean Enterprise around existing efforts. Only if a gap is determined will a new effort be started. The authors identified potential partners in the linkage's sections, with a bias towards those that the authors are aware of, this is however not an exhaustive list. The aim is to show that collaborative and complementary action will drive the change we seek. Other potential partners are welcome. Links to webpages are provided within this section and an entire list of web links are available in Appendix 2.

To enable further discussions with the many stakeholders in the Ocean Enterprise who should have a say in who and what entities are best suited to carry out an action going forward, the Roadmap does not identify specific actors to accomplish the action pathways. There will be an opportunity for engagement in future *Dialogues with Industry* series, launching in 2024.

III. Priority Areas

This section describes how the high-priority actions pathways will advance the challenges identified under the three priority areas. The challenges associated each of the priority areas are as follows:

- **Improving the Marketplace** focuses on improving the market visibility, aggregation of demand and rethinking risk to accelerate growth.
- **Collaboration to Grow and Impact Change** focuses on data as an asset and missions as a service, private-public exchange, standards, developing intermediaries, and public and private data access.
- **Shaping the Future** focuses on workforce development and the utilization of emerging technologies in the public sector services.

This is illustrated in **Figure 1** in the Executive Summary. We anticipate that as each challenge is further scoped, additional action pathways will be identified to achieve the success indicators.

Improving the Marketplace

One of the primary challenges identified in the *Dialogues with Industry* sessions was the lack of a well-functioning marketplace for ocean data, information, and knowledge. Although most of the current funding for sustaining ocean observations comes from the public sector, the private sector has recently expanded its investment into the Ocean Enterprise. The funding in many cases is concentrated in research, with only a fraction of the funding finances sustained observation operations. As new markets emerge, the private sector needs to be aware of and prepared to engage in these high-priority actions.

To address these challenges, it is necessary to assess and track the market size and potential of ocean technologies, data, knowledge, and services. This will enable us to estimate and communicate the economic value of the Ocean Enterprise, as well as to identify gaps and opportunities for growth. Furthermore, this will help us to increase the visibility and recognition of the Ocean Enterprise as a distinct sector or as a key enabler of the Blue Economy.

DIALOGUES WITH INDUSTRY

Challenge: Market visibility

Two market economy related challenges were identified in the *Dialogues with Industry*. The first challenge is that Blue investment lags Green investment, partly due to the perceived risk in Blue investment. The Ocean Enterprise can help mitigate the risk and become an attractive growing market itself, if there is a greater understanding of the Ocean Enterprise.

The second challenge is whether the industry component of the Ocean Enterprise will be able to grow as a stand-alone sector or whether this component will only be recognized as being supportive of the Blue Economy. The Ocean Enterprise is not yet recognized or understood as a market opportunity. This lack of recognition has resulted in a weak investment inflow into the Ocean Enterprise – Industry component that aims to deliver technology or services. As a result, the financing and funding available for these companies' development and growth have been greatly reduced. This issue is partly due to the absence of systematic accounting of the size and growth of the Ocean Enterprise – Industry component.

Success indicators

- Determination of the global value and potential of the Ocean Enterprise – Industry component.
- Establishment of a systematic, repeatable method to continuously update the value of the industry component of the Ocean Enterprise.
- Systematic articulation of the value of the Ocean Enterprise to other industry sectors.
- Creation of a location where curated market reports are accessible.

Action pathways

- Authoritative targeted market studies.
- Centralized repository for Blue Economy literature that includes market reports, impact studies, emerging technology assessments, and a defined “library” of ocean technology.
- Develop curated impact studies to raise awareness of the importance of a thriving Ocean Enterprise.
- Create centralized, defined, and credible “library” of ocean technology.

Linkages to other initiatvies

- Organization for Economic Co-operation and Development (OECD) Ocean/Blue Economy studies
- MTS, in 2024, will define a framework for the digital ocean enterprise repository.
- The United States Department of Commerce has developed Ocean Satellite accounts to articulate the value of the US Blue Economy.
- EU – Blue Invest

Challenge: Aggregation of Demand

Aggregating market demand for ocean observing technology, data, and information could create markets of sufficient size to attract industrial involvement as well as development investment and financing.

However, neither the public nor the private sector currently has a forum to discuss requirements, and there is not a defined and diverse ecosystem of paying customers to foster and sustainably support new venture investment and business creation. New markets on the horizon, such as offshore wind, aquaculture, marine carbon renewal sequestration, and understanding biodiversity, are realizing the need for ocean information. Innovation will be driven by these applications, rather than generalized concepts such as enhancing data collection.

Success indicators

- Clear development targets to reach application and societal needs.
- Evidence that the Ocean Enterprise is growing, and Blue investment has increased.

Action pathways

- Develop economic benefit metrics of ocean observing that can be adopted by both public and private entities.
- Aggregation of demand of existing ocean observing technology, services, data, and information by public and private sector and of innovation and development needs (i.e., through fostering active engagement and information exchange.)

Linkages to other initiatvies

- IOOS Benefits of Ocean Observing Catalog (BOOC)
- Consider the role of GOOS (networks, EOVs, user requirements) in the aggregation of demand and work towards a *Dialogues with Industry* special session – GOOS, with MTS and private sector.
- Blue Economy: EU Blue Champions

Challenge: Rethinking Risk to Accelerate Growth

Risk is a cost driver and a limiting factor in market growth. For example, the demand for low-cost and easy-to-use sensors is strong. However, the cost of developing such sensors is very high for the private sector.

To make technology development more attractive, the risks associated with these higher costs need to be acknowledged and reduced. This could be achieved through large enough market demand or targeted co-investment by the government. Another factor that increases the risk for the private sector is the need to have an enabling environment to move toward economies of scale and away from high-cost, high-risk, customized, one-off, short-term projects. The current market size and fragmentation make it difficult to quickly scale manufacturing. Furthermore, the public sector funding cycles supporting ocean observing are predominantly short-term (year/few years), which hinders the consistent development of needed technology.

Success indicators

- Longer-term public-sector investment in ocean platforms and systems and sustainable observations to lower risk to Ocean Enterprise research and development.
- Documenting hybrid models of platforms and systems, i.e., public/private.
- Create a vibrant and dynamic community of stakeholders who can share knowledge, exchange ideas, and work together to achieve common goals.

Action pathways

- Rethinking funding to identify potential funding streams to support the acceleration of technology to market.
- Rethink public funding impacts for non-sustained, short term funding horizons.
- Transparent and international product and development marketplace/communication stage to aggregate demand, and gain market overview.

Linkages to other initiatvies

- The Sustainable Blue Economy Partnership (and JPI Oceans) are concerned with topics that overlap with the Action Pathways.
- MTS, in 2024, will convene additional *Dialogues with Industry* in partnership with GOOS and NOAA.

Collaboration to Grow and Impact Change

Another challenge of the Ocean Enterprise is to understand and bridge the differences between the motivations, timelines, and expectations across the ocean enterprise entities.

Growth and change are linked largely to changing the government and societal perceptions. These entities include the public sector, which focuses on the public good for broad societal needs; the private sector, which centers on shareholders' and stakeholders' specific interests, solution offerings, profit, and public good; and the academic sector, which focuses on the basic and applied research needed to continually improve our knowledge of ocean processes through observations and models. These differences may create gaps or barriers in collaboration and innovation among ocean enterprise entities and in the development and implementation of a multi- sectoral ocean observing system.

Embracing the paradigm shift from platform and sensor acquisition to data and mission as a service can help optimize the efficiency, effectiveness, and impact of the ocean observing system, as well as create new markets and opportunities for ocean technologies, products, and services. However, this shift requires addressing some trade-offs and considerations, such as data quality, intellectual property rights, commercial viability, and customer requirements.

To address these challenges, it is essential to identify challenges and opportunities of existing ocean observing network business models; convene the major observing network owners to identify practical applications of a hybrid (public/private) system; and develop and adopt end user licensing agreements.

Image credit: GOOS

Challenge: Data as an Asset and Missions as a Service

In recent years, there has been a surge in new commercial operators both taking observations and delivering this data to users, following trends seen in other earth information sectors, such as new earth satellite ventures. To commercial operators, this data is viewed as an asset, and there is a tension between the concept of free and open data in the public sector and models where data has value.

However, the Dialogues uncovered that many commercial operators are willing to provide this data free to science, and there were examples in ocean observing and other sectors of agreements that encompass downstream use and re-use of data. There is recognition that a hybrid public/private global observing system has the potential to advance the observing system and information delivery more rapidly to meet user needs, but there are few practical examples of how to accomplish this. As the number of private sector businesses offering data, missions, and services increases, there is not yet a consensus on a data licensing schema for commercially procured data that is consistent with ocean observing norms and offers value to commercial operators.

Success indicators

- GOOS and other observing networks are co-developed and multi-sectoral with new technologies and services being rapidly integrated.
- Develop business models that increase the private sector role in the delivery of missions and data as a service.

Action pathways

- Develop and adopt end user licensing agreements.

Linkages to other initiatvies

- NASA Commercial Data Buys - EULA

DIALOGUES WITH INDUSTRY

Challenge: Private-Public Exchange

To establish a hybrid public-private ocean observing architecture, it is essential to foster active engagement and exchange between the public and private sectors. This can support the development of deeper relationships, the active participation of these partners towards co-defining solutions, and ultimately understand how the Ocean Enterprise can better function to the benefit of society and all partners involved.

The exchange can serve as a platform for stakeholders to share their perspectives, ideas, and best practices, identify common goals and priorities, foster collaboration, and innovation, and facilitate the co-creation of solutions that meet the needs of all stakeholders. By bringing together the public and private sectors, the exchange can help to create a more sustainable and equitable Ocean Enterprise.

Success indicators

- Establishing a recognized and vibrant exchange for the private-public sector that has a successful track record of developing solutions and supporting the evolution of the Ocean Enterprise.
- An increase in the number and diversity of participants in the Ocean Enterprise over time.

Action pathways

- Foster active engagement and exchange on issues raised in the *Dialogues with Industry*.
- Create a technology forum to facilitate systematic dialogues between the private, public, and academic sectors to promote industry within public observing systems.

Linkages to other initiatvies

- Public-Private Engagement - WMO
- Ocean Decade Corporate Data Group

DIALOGUES WITH INDUSTRY

Challenge: Standards

A lack of standards in the Ocean Enterprise has been highlighted as a limiting factor for a thriving and growing private sector engagement. For the private sector, this means that there is no defined and common target to achieve for data or instruments provided, and for the public sector, there is no measure or 'standard' to hold private sector providers accountable for delivery.

The private sector indicated that standards, if used well, can create a 'level playing field' for competition, such that achieving the standard would mean that the data/instrumentation is fit for purpose. However, overuse of standards could stifle innovation. It was noted that standards may need to be linked to use, e.g., temperature for climate applications vs. weather, and open ocean vs. coast. Further detailed collaboration with the industry is required to identify what would make useful standards, however, this topic came up across all the Dialogues as an important area to address. Standards will act not only as a communication tool but will also bring together both the ocean observing public and private sectors to agree on globally accepted measurements.

Success indicators

- Establishing recognized definitions of what we mean by standards for the Ocean Enterprise, and a set of standards that are used, understood, and accepted by government and industry.
- These standards should lead to greater participation by industry players in areas where standards exist, and where the definition of a standard has led to more rapid development of a needed technology.

Action pathways

- Identify standards that will significantly advance the Ocean Enterprise.
- Identify community motivation and incentives for incorporating standards.
- Identify a facilitator that will work with governments and industry to establish these standards.
- Determine a location for a repository for standards/best practices.

Linkages to other initiatvies

- GOOS standards efforts under the EOVs, ECVs fit for purpose engagement.
- NATO Centre for Maritime Research and Experimentation (CMRE) effort on digital underwater communications standards.
- ISO 22013:2021- Marine environment sensor performance.
- MTS will host a special session during Oceanology International (OI) 2024 London on landscaping standards.

DIALOGUES WITH INDUSTRY

Challenge: Developing Intermediaries

Access to ocean information is crucial for the betterment of society. A thriving community of intermediaries, who use ocean data to deliver information services, is essential to achieving this long-term goal. Presently, the public sector delivers most of the ocean information services to society, both nationally and globally, as the private sector does not play a significant role in this domain.

Although there are barriers to the private sector's development of services, there is also a considerable opportunity, given the increasing societal need for ocean information. Therefore, there is a need to develop growth and more thriving interaction in this space.

Success indicators

- Increased access to ocean information services for end users.
- A more diverse range of ocean information services delivered by intermediaries.
- A more thriving interaction between the public and private sectors in the delivery of ocean information services.

Action pathways

- Systematic engagement with intermediaries to grow the intermediaries component.
- Translate user needs to new public/private partnerships.
- Identify issues with public data portals that would impair access and use by industry.

Linkages to other initiatvies

- EMODnet is an EU effort to process the data according to international standards and make that information freely available as interoperable data layers and data products.
- The United States Integrated Ocean Observing System (IOOS™) data management and communications and Regional Association data portals.
- Australia's Integrated Marine Ocean Observing System (IMOS) - data portal
- Canada's Integrated Ocean Observing System (CIOOS) - data portal.
- Copernicus Marine Service – free and open marine data and services

Challenge: Public and Private Data Access

Data collected by the private sector for other private sector actors is typically not freely available. However, this data can have value to other users beyond the narrow frame of the initial data collection 'customer'.

Private sector data is often of high resolution but spatially and temporally limited. Nevertheless, it can add value to the often-broader scale, sustained public sector observations. A sustainable future requires us to look at the efficiencies of making such data available to those who need it. The potential benefits include saving time and resources and enabling the capture of historical environmental status. However, there is a cost to making this data available, and the quality is often unknown. Therefore, interested parties could engage with each other to explore such data options through a suitable mechanism.

Success indicators

- Increased access to data of value for end users.
- Data sharing will support the growing demand for training data in Artificial Intelligence (AI) and Machine Learning (ML) models to support new applications.
- A more thriving interaction between the public and private sectors and an increased role played by the private sector in the delivery of data of value.

Action pathways

- Create frameworks and mechanisms to make privately owned ocean science data publicly available.
- Create data marketplaces.

Linkages to other initiatvies

- SEABED2030 as an example of mobilizing initiative motivating data sharing.
- Ocean Decade Corporate Data Group
- Schmidt Ocean Institute: Open Ocean Data Workshop: Credit where Credit is Due

Shaping the Future

The growth of the Ocean Enterprise market is dependent on the availability of a highly skilled and diverse workforce that can meet future demands, as well as significant public and private investment in infrastructure that can enhance the value and impact of ocean data, information, and knowledge. The Ocean Enterprise requires a range of competencies and qualifications, from technical skills in ocean observation and data analysis to business skills in marketing and management, as well as soft skills in communication and teamwork. This necessitates human resources investments in both the public and private sectors.

Infrastructure investment includes research and development projects, technology transfer programs, innovation ecosystems, market access strategies, standards, regulation frameworks, and data management and sharing platforms. Emerging technology can present opportunities to enhance existing infrastructure, but adaptation of such new sensors, systems, and services will be limited without substantial efforts to create the conditions that allow for improved agility. To address these prerequisites for a thriving Ocean Enterprise market, the following actions have been suggested for addressing these requirements.

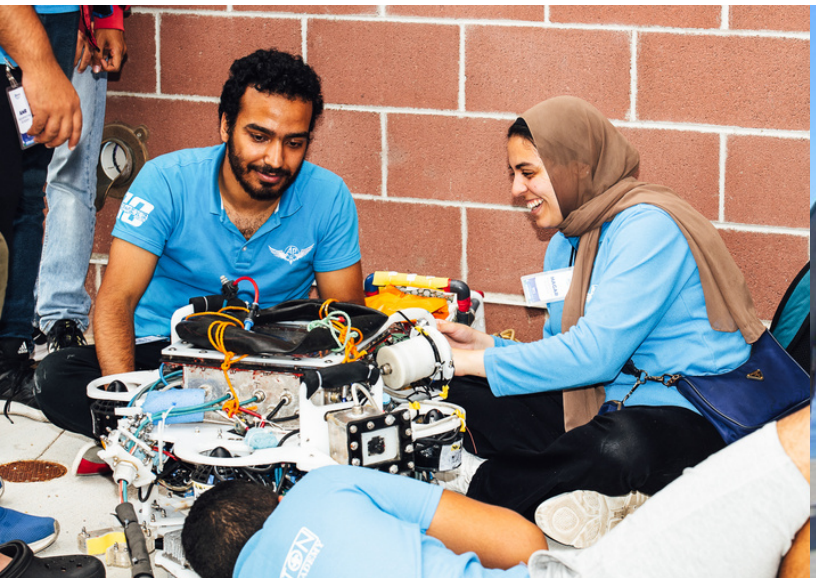

Image credits: Marine Advanced Technology Education (MATE; left), *NOAA (right)*

DIALOGUES WITH INDUSTRY

Challenge: Workforce Development

A highly skilled, diverse, and available workforce does not currently exist to ensure a thriving Ocean Enterprise, and this shortfall is expected to impact the Ocean Enterprise at all levels.

Success indicators

- Annual growth in number of jobs in the Ocean Enterprise sector.
- Annual growth in graduates in the basic and applied sciences relevant to the Ocean Enterprise sector.
- Growth in the global Ocean Enterprise sector as a proportion of global GDP.

Action pathways

- Develop promotional career campaigns that are linked to major global issues where the Ocean Enterprise can play a major role.
- Develop an Ocean Enterprise-skill needs assessment and communications plan for the results, working with the membership of MTS and MTS-like trade groups as well as blue tech clusters to understand workforce trends.

Linkages to other initiatvies

- Ocean Decade – Ocean Bridges - expertise-sharing between Early Career Ocean Professionals (ECOPs) and Experienced (mid to late career) Ocean Professionals
- Ocean Decade - Vision 2030 Writing Group
- COVE – ocean internship COVE is enabling the workforce of the future.
- MTS to co-host with NSF and NOAA, an industry focused workforce initiative in 2024 at AGU Ocean Sciences.
- MTS, National Science Foundation (NSF OCE-2308556), is developing microcredentials for the Ocean technical workforce.
- Preparing a Workforce for the New Blue Economy
- Canada's Ocean Supercluster Talent Strategy

DIALOGUES WITH INDUSTRY

Challenge: Utilization of Emerging Technologies in Public Sector Services

The growth of the Ocean Enterprise market is inhibited by the slow adoption of emerging technologies, which are necessary to ensure systems evolve for the improved delivery of public services. Although public utilization of emerging technologies is often slow to occur, it is crucial to ensure that systems evolve to meet the needs of society. Therefore, it is important to identify and address the barriers to the adoption of emerging technologies in the Ocean Enterprise market to promote its growth and development.

Success indicators

- Increase the number of emerging Ocean Enterprise technologies that are integrated into public sector services to meet identified needs.
- Increase the number of collaborative tech development public-private partnerships in the Ocean Enterprise.

Action pathways

- Promote the growth of and collaboration among Bluetech clusters, incubators, and accelerators
- Establish testbeds and demonstration platforms for R&D to evaluate the utilization of emerging technology in current operational systems.
- Develop roadmaps for efficient scaling and support of transition of non-public ocean observing platform/sensors.

Linkages to other initiatvies

- NOAA/IOOS Ocean Climate Resilience Accelerator Program
- Synchro - A Co-designed Testbed to Synchronize and Evolve Technology Solutions - hosted at MBARI
- Testbed and demonstration examples:
  - PLOCAN
  - Digital Ocean Lab
- AtlantOS (and others) are investing in low-cost fora to help match low-cost emerging tech with end users, including training workshops, and SOPs to support troubleshooting in the field.
- Digital Twins of the Ocean
- US Harmful Algal Bloom Control Technologies Incubator (US HAB-CTI)
- Shaping an Ocean Of Possibilities for science-industry collaboration (SOOP) project builds sustainable structures for ocean observation.
- Canada's Ocean Supercluster core program and calls for proposals
- COVE and Innovate UK partner on global incubator program
- Creative Destructive Lab
- EU TechOceans – developing innovative technologies and methods

IV. Going forward

The *Dialogues with Industry* initiative has been instrumental in defining and refining a set of clear priority actions that function across the ocean information value chain to lower barriers and increase opportunities for the private sector in growing the Ocean Enterprise. We hope you find resonance with this succinct set of action pathways as outlined in the *Dialogues with Industry* Roadmap.

This roadmap is not intended to gather dust in a drawer; it is the start of practical work towards achieving a vision of a more integrated public-private ocean enterprise, expanding the ocean observing system, and making it more efficient and fit for purpose.

Moving forward, four things will happen:

1. MTS and GOOS will work together to develop the **pathways with a global focus**, supported with funding and staff from IOOS and NOAA.

2. The current government-industry-science organizing committee will recruit more members and become a ***Dialogues with Industry* Steering Committee** to continue to provide a breadth of advice.

3. A ***Dialogues with Industry* Team** will form under MTS to develop the pathways outlined here.

4. We ask for your **continued support, interest, and commitment** to making the pathways effective and impactful across private, government, and science. Sign up to be part of our *Dialogues with Industry* Fora and participate in the Dialogues as they continue.

The *Dialogues with Industry* Roadmap will be a living document and progress against these action pathways will be reviewed periodically and new action pathways will be added.

V. Acknowledgements

The authors and organizing committee core members, listed in Appendix 3, would like to express our sincere gratitude to all the participants and observers of the *Dialogues with Industry* initiative.

MTS efforts identified in the Roadmap are largely funded by the Department of Commerce NOAA – grant, in support of the Resilient Coastal Communities and Economies Strategy Priority detailed in NOAA-NFA-NFAPO-2021-2006626.

We would like to thank the GOOS Office for supporting the development of the *Dialogues with Industry* and the Roadmap, including communications, as a part of its regular budget under the IOC/UNESCO.

We would like to thank Kongsberg Discovery and L3Harris for supporting the development of the *Dialogues with Industry and* the Roadmap, through their support of the executive team.

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: Pathways and Priority

Focus areas	Challenges	Top Level Potential Pathways
	HIGH PRIORITY	
Improving the Marketplace	Market visibility	Authoritative targeted market studies
		Centralized repository for Blue Economy literature that includes market reports, impact studies, emerging technology assessments, and a defined "library" of ocean technology
		Develop curated impact studies to raise awareness of the importance of a thriving Ocean Enterprise
		Create a centralized, defined, and credible "library" of ocean technology
	Aggregation of Demand	Develop economic benefit metrics of ocean observing that can be adopted by both public and private entities
		Aggregation of demand of existing ocean observing technology, services, data, and information by public and private sector as well as of innovation and development needs, i.e., through fostering active engagement and exchange of information
	Rethinking Risk to Accelerate Growth	Rethinking funding to identify potential funding streams to support the acceleration of technology to market
		Rethink public funding impacts for non-sustained, short-term funding horizons
		Transparent and international product and development market/communication to aggregated demand

DIALOGUES WITH INDUSTRY

Focus areas	Challenges	Top Level Potential Pathways
HIGH PRIORITY		
Collaborations to grow and Impact through societal/ governmental change	**Data as an Asset and Mission as a Service**	Develop and adopt globally accepted end user license agreements
	Private/ Public Exchange	Foster active engagement and exchange on issues raised in the *Dialogues with Industry*
		Create a technology forum to facilitate systematic dialogues between the private, public, and academic sectors to promote industry within public observing systems
	Standards	Identify standards that will significantly advance the Ocean Enterprise
		Identify community motivation and incentives for incorporating standards Identify a facilitator that will work with governments and industry to establish these standards
		Determine a location for a repository for standards/best practices
	Intermediaries	Systematic engagement with intermediaries to grow the intermediaries component
		Translate user needs to new public/private partnerships
		Identify issues with public data portal that impair access and use by industry sector
	Public and private data access	Create frameworks and mechanisms to make privately owned ocean science data publicly available
		Create data marketplaces

DIALOGUES WITH INDUSTRY

Focus areas	Challenges	Top Level Potential Pathways
HIGH PRIORITY		
Market Elements - Shaping the Future	Workforce	Develop promotional career campaigns that are linked to major global issues where the Ocean Enterprise can play a major role
		Develop an Ocean Enterprise-skills needs assessment and communications plan for the results, working with the membership of MTS and MTS-like trade groups as well as blue tech clusters to understand workforce trends
	Utilization of Emerging Technologies in Public Sector Services	Promote the growth of and collaboration among Bluetech clusters, incubators, and accelerators
		Establish testbeds and demonstration platforms for R&D to evaluate the utilization of emerging technology in current operational systems
		Develop roadmaps for efficient scaling and support of transition of non-public ocean observing platforms/sensors
MEDIUM PRIORITY		
Improving the Marketplace	Aggregation of Demand	Best practices for developing policy papers for public/elected officials
		Mechanisms for Ocean Enterprise to actively write/influencing conventions e.g Task Force on Nature Related Financial Disclosure
		Best practices, advocacy and Roadmap for collaboration with public media
	Rethinking risk to accelerate growth	Trade off Dialogues to understand user needs and risks and trade offs between the two
		Rethink public funding impacts for non-sustained, short term funding horizons
Collaborations to grow and Impact through societal/ governmental change	Change perception of ocean information	Promote united branding on ocean technologies to change the perception of ocean information from ancillary to essential
	Intermediaries	Translate user needs to new public/private partnerships

Focus areas	Challenges	Top Level Potential Pathways
MEDIUM PRIORITY		
Market Elements - Shaping the Future	Workforce	Advance scientific learning through remote learning
	Utilization of Emerging Technologies in Public Sector Services	Facilitate the transfer of ocean sensor technology across components of the Ocean Enterprise (i.e. science to industry linkage)
		Leverage industries not in the ocean arena at all (e.g. fashion industry, etc.) to establish partnerships for the extension of ocean observing, e.g., measurements on offshore structures or merchant vessels
		Identify and sponsor pilot projects would highlight new technologies that represent a multi-sectoral ocean observing architecture to solve a problem/ocean observing gap
LOW PRIORITY		
Improving the Marketplace	Bringing in New Actors	Inviting traditional and non-traditional actors to enable more SMEs to become active in ocean enterprise activities
Collaborations to grow and Impact through societal/ governmental change	Change perception of ocean information	Co-create an Ocean Decade Program focused on strengthening the commitment
		Address Ocean Literacy at the Undergraduate/Graduate level with the use of real-world ocean problems incorporated in non-ocean disciplines
Market Elements - Shaping the Future	Utilization of Emerging Technologies in Public Sector Services	Expose AI experts to ocean science problems by developing ocean data as the training data
		Early engagement of industry in product development in public sector
		Support Ocean Decade actions that promote tech clusters/ incubators/accelerators
		Embrace new collaboration tool within academia e.g. coffeehouse - focused on technology accelerated to commercialization

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Appendix 3: Organizing Committee Core Members

Sector	Affiliation	Name
Public - United States	NOAA	Matthew Hodanbosi
Public - United States	NOAA	Zack Baize
Intergovernmental	GOOS IOC/UNESCO	Emma Heslop
Intergovernmental	GOOS IOC/UNESCO	Emily A. Smith
Industry	Kongsberg Discovery	Peer Fietzek
Industry/Not-for-profit	L3 Harris/MTS	Donna Kocak
Nonprofit/NGO	MTS	Brendal Towsend
Nonprofit/NGO	MTS	Zdenka Willis

The Global Ocean Observing System

marine technology SOCIETY

2021 2030 United Nations Decade of Ocean Science for Sustainable Development

DIALOGUES WITH INDUSTRY

Roadmap

Maturing the Ocean Enterprise to Deliver Essential Societal, Economic, and Environmental Benefits

29 January 2024

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