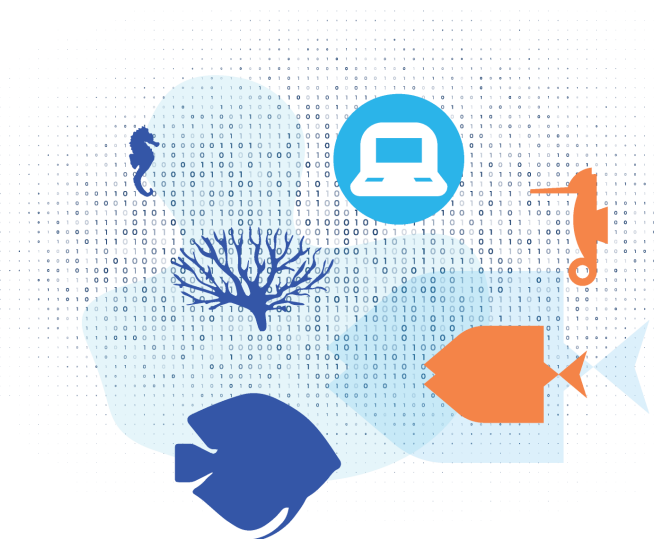# DIGITAL OCEAN FORUM 2024

## SCIENTIFIC & TECHNICAL WORKSHOP
## HIGH-LEVEL LEGACY EVENT

### 12-13 JUNE 2024
### Palace of the Academies, Brussels



## REPORT

### Editor & Rapporteurs:

Julia Vera, Seascape Belgium

Lillian Diarra, Mercator Ocean International

Salvador Fernández, VLIZ

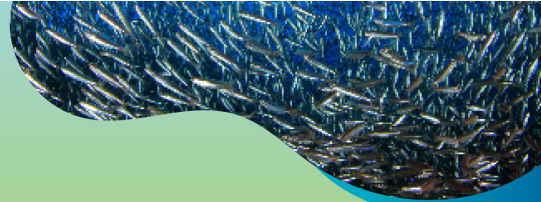Tim Collart, Seascape Belgium

Vicente Fernández, Seascape Belgium

# Table of Contents

## 1. About DOF2024 and this Event Report

The **Digital Ocean Forum** (DOF) is an annual event geared at co-designing and co-creating the European Digital Twin Ocean. Co-organised by the **European Commission**, **Mercator Ocean International** (MOi) and the **Flanders Marine Institute** (VLIZ) under the Belgian Presidency of the Council of the European Union, the third edition of the DOF (DOF2024) was held in Brussels (Belgium) on 12 and 13 June 2024.

DOF2024 gathered over 200 participants from the European Commission, national, regional, and local governments, the marine science & research community, and other stakeholders to unveil the pre-operational prototype of the European Digital Twin Ocean core infrastructure (EDITO). The prototype is the result of the work being undertaken in the framework of the EDITO-Infra and EDITO Model Lab projects, which has been informed by extensive stakeholder input and feedback gathered during DOF2022 and DOF2023 editions, including via beta-testing by selected users.

Like previous editions, the event span over two days of exchanges. A **Scientific & Technical Workshop** was held on 12 June, aimed at engaging and gathering further input and feedback from the community on EDITO's capabilities and user requirements. A **High-Level Legacy Event** was held on 13 June, geared at showcasing, discussing, and establishing long-term perspectives around the societal and policy value of the European Digital Twin Ocean (DTO), to inform priorities for future development.

This report provides a summary of the discussions and key messages that emerged from the **Scientific & Technical Workshop** of DOF2024, as well as offering a snapshot of the proceedings of the **High-Level Legacy Event**.



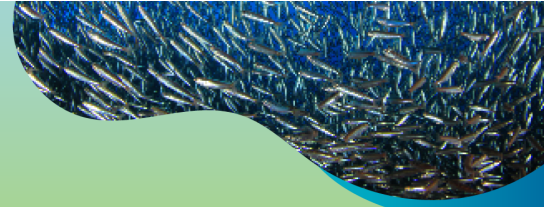**Image 1.** Representatives of the European Commission at DOF2024
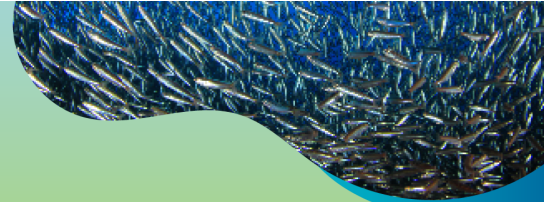
## 2.   Objectives and structure of the Scientific & Technical Workshop

The key objective of the **Scientific & Technical Workshop** of DOF2024 was to present, discuss, and gather feedback on the first prototype of the core infrastructure of the European DTO, ensuring its co-development as a collaborative effort that incorporates the diverse perspectives of the European marine research, innovation & (data) science community. The workshop is an opportunity to further engage directly with national and European projects and initiatives that can shed light into the scientific and technical developments that need to be considered when shaping the European DTO. This hands-on approach ensures active community involvement in shaping a DTO that reflects the current state-of-the-art.

The **Scientific & Technical Workshop** was structured around two distinctive blocks, namely:

- An introductory **panel** geared at exploring the current capabilities of the EDITO platform, including insights from early beta-testers, to assess current functionalities and gather further user feedback from participants, towards informing its ongoing evolution.

- Three **break-out sessions** drilling deeper into selected topics, aimed at gathering input from participants on relevant technical and strategic topics to inform EDITO developments and to guide the co-creation of the European Digital Twin Ocean, namely:

  o **BREAKOUT SESSION 1:** Exploring the EDITO Data Lake & Modelling Engine and addressing user needs: Challenges & opportunities.

  o **BREAKOUT SESSION 2:** Connecting an interoperable and cohesive network of digital twinning initiatives and applications via EDITO.

  o **BREAKOUT SESSION 3:** Delivering to policy objectives: A vision for the European Digital Twin Ocean.

These blocks were preceded by a Welcome panel chaired by the event co-organisers, including EC representatives from the Directorate General for Research & Innovation (DG RTD) and the Directorate General for Maritime Affairs and Fisheries (DG MARE), and from MOi and VLIZ. A closing panel presented key messages and conclusions stemming from the discussions. The full event Agenda is included in the Annex of this document.

#MissionOcean   #DOF2024
#EUDTO   #edito_dto

## 3.   Summary of key messages & feedback from the Workshop

### 3.1.   PANEL: Exploring the current capabilities of the EDITO platform

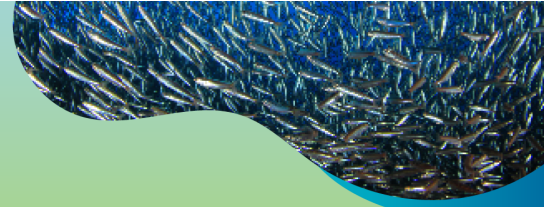**Rapporteur:** Salvador Fernandez, VLIZ

#### 3.1.1.   Session objectives and topics covered

The key objective of this session was to introduce the current capabilities and functionalities of the EDITO platform, share the experience of current beta-testers, and open the floor to participants for questions related to the platform, its functionalities, and/or the foreseen technical roadmap.

Laurence Crosnier (Mercator Ocean International) chaired the session, and Quentin Gaudel and Chloe Delpont Ramat (Mercator Ocean International) offered a live demonstration of the EDITO platform. The key topics covered included the platform's design criteria, architecture, and functionalities. User testimonies from Mateo Mikos (Seascape Belgium), Lorinc Meszaros (DELTARES), and Mario Salinas (CMCC) followed, highlighting practical experiences and feedback (Image 2). They praised the efficient coding environments, fast data processing, and comprehensive service catalogues, which simplify cloud computing for ocean scientists. Suggestions for improvements from a user perspective were also given, namely the need for more tutorials, in addition to those currently offered, and improved credential management. Challenges were also raised, such as the complexity of working with cloud workflows. In spite of these, the platform's integration capabilities and potential for developing applications (such as e.g., a zero-carbon shipping app) were overall positively highlighted and received with enthusiasm by the participants attending the event, demonstrating community trust on EDITO's promise for advancing ocean data processing and accessibility.



**Image 2.** EDITO beta-testers offering their testimonies at DOF2024

### 3.1.2.  Main topics of interest, key messages and recommendations

Participants were highly interested in the practical use of EDITO, particularly in how it integrates data from **Copernicus Marine Service** and **EMODnet**. There was significant interest in the functionalities for exploring, visualizing, and creating data services, with attendees appreciating the comprehensive tutorials and online support.

Several questions arose about the differences between services and processes, with explanations clarifying that services are interactive tools while processes handle specific data inputs and outputs. The potential for "***what if***" scenarios to generate new data was also a key topic, with participants eager to look deeper into demonstrations of these capabilities.

Reactions to user testimonies highlighted the need for improved documentation and support, particularly for credential management and cloud workflow setup. Suggestions included enhancing the visibility of running processes, simplifying HPC connections, and implementing quality control for contributions. Overall, the discussion underscored the importance of making the platform more user-friendly, and ensuring robust support as it moves towards broader accessibility.

- Several EDITO features are very well received and appreciated,  namely:
    - Easy access to large computational resources that can be run anywhere.
    - The User Interface is a big improvement compared to running services and processes from a terminal.
    - Tutorials are also extensive and explain several features.

- Suggestions for improvement of some aspects were raised, namely:
    - While easy to understand, tutorials and documentation are not comprehensive enough. There are certain functionalities for which availability and use possibilities is not clear enough.
    - There is no quality control to the process that are created ad-hoc.
    - HPC connections with other platforms (e.g. EuroHPC) are not yet easy to perform.
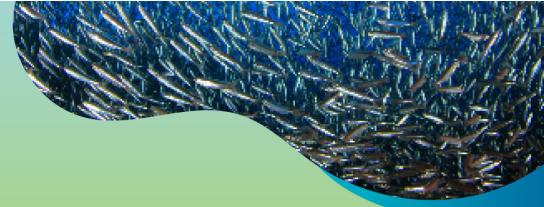
## 3.2. BREAKOUT SESSION 1: Exploring the EDITO Data Lake & Modelling Engine and addressing user needs: Challenges & opportunities

**Rapporteur:** Tim Collart, Seascape Belgium - EMODnet Secretariat

### 3.2.1. Session objectives and topics covered

The key objective of this session was to look deeper into the current capabilities offered by EDITO, including the EDITO Data Lake and the EDITO Modelling Engine, discussing their evolution towards further alignment with user needs and expectations. This breakout session was chaired by Klaas Deneudt (VLIZ), who introduced the panel members and explained the goals of the sessions. Through a poll, the audience was asked to identify themselves (as e.g., a data professional, modeller, etc) and indicate if they had any prior experience working with the EDITO platform (see Section 5.2). Conor Delaney (Seascape Belgium - EMODnet Secretariat), Laurence Crosnier (MOi) and Patrick Gorringe (Swedish Meteorological and Hydrological Institute - EMODnet Physics) contributed with presentations to set the topics for discussions.

Conor Delaney highlighted that the EDITO infrastructure allows users to tackle "big data" challenges. For Copernicus Marine, it is "big data by volume", while for EMODnet it is big data in terms of complexity of the number of parameters and the granularity of the data. EDITO will enable users to create new marine data products and services, contributing both to the marine data science community and to wider society. Delaney invited participants to reflect on what marine data products and services they would like to see.

Laurence Crosnier indicated that in the EDITO project, both Copernicus Marine and EMODnet have been working together to build the European Digital Twin infrastructure that integrates these two EU flagship marine services in a single digital framework. The platform allows to explore the available data and tools, but also allows to create and contribute new data products and tools. EDITO aims to be a collaborative platform that meets the needs of current and future marine research and innovation projects. She encouraged the audience to take part in this co-design process to build the platform to meet their needs.

Patrick Gorringe highlighted the uniqueness of a platform like EDITO that can be built from the ground up based on user needs, encouraging everyone to contribute. He further highlighted that the next big thing in ocean observation will be citizen science data. He argued that, historically, it had been met with a lot of scepticism in terms of data quality, but there is a big change going on and the potential for citizens contributing to marine data is huge. As an example, he mentioned the contribution of over 100,000 CTD profiles collected by divers that was already operationally used for improving hurricane forecasts in the United States. He argued that having data in locations where nothing else is available is more important than the quality/uncertainty of that data. EDITO will have to be ready to deal with this new source of big marine citizen science data and consider the challenges involved (e.g. meet GDPR rules around personal data).

These opening interventions were followed by an extensive Q&A session with the audience where many different topics were discussed. In the close of the session, the audience was asked to reply to several poll questions regarding their experience and future needs of EDITO, as summarised in the next section and further detailed in Section 5.2.

### 3.2.2. Main topics of interest, key messages and recommendations

Initial questions and comments pointed at the importance of data availability and formatting. For example, representatives of the Ocean-ICU project indicated their need for cloud optimized

time series data, to serve their modelling. Other participants referred to the fact that the majority of "*what-if*" scenarios in EDITO will need atmospheric data. On the topic of citizen science, and ways to collect it, an example of web page scraping to get biodiversity information was given.

Regarding "*what-if*" scenarios, there was interest in a tool within EDITO that would allow to translate available, public data (whose handling requires a whole set of expertise and skills) into simpler, ready to use "what-if" scenarios accessible to wider audiences. Although there are already some examples of "what-if" scenarios in EDITO, the development team explained that this is a contribution that is expected to come from the community that is co-creating the European Digital Twin Ocean, leveraging the EDITO platform.
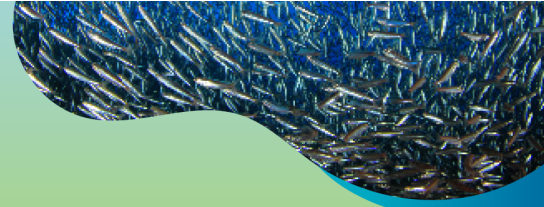


**Image 3.** Participants during Breakout Session 1

Participants were also interested in better understanding the relationship between Copernicus Marine Service, EMODnet, and EDITO. For example, a question from a data producer standpoint whose data is dynamic overtime was "*how is the data in EDITO different from what is in EMODnet or Copernicus Marine?*". Conor Delaney indicated that what is available in the EMODnet catalogue is harvested into the EDITO catalogue and updated at a certain frequency. In the case of Copernicus Marine, however, there is no difference between what users can access through its catalogue and through the EDITO platform.

Another question referred to the use of data in EDITO, and whether data providers had a way of monitoring how their data is used. The possibility to analyse the usage of data on the EDITO platform and reporting back to data providers was deemed feasible and interesting. Some participants argued that this monitoring capability should be in place before the platform is operational.

Other participants highlighted that, in order to do on-demand modelling on the EDITO platform, there is a need for much more data than what is currently available in EMODnet and Copernicus Marine, especially very localized data (e.g., coastal data), which then would need to be stored on EDITO. Also, that there is a need efficient extraction of the data. This is available for Copernicus Marine (ARCO format), but it would be good to also implement this for EMODnet

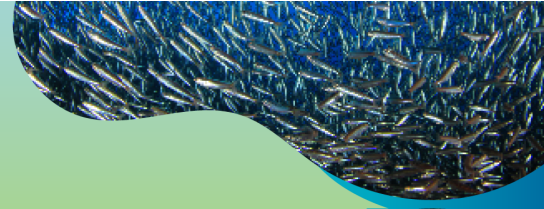data. It was highlighted that the process of offering EMODnet data in ARCO format is already in progress.

Participants also enquired about EDITO's approach to building relationships amongst datasets, such as those needed to produce simulations varying certain parameters. The development team explained that building these kind of relationships falls outside of the scope of EDITO, but that rather EDITO will allow users to contribute these kinds of connected datasets/services to the platform. Further connecting with data requirements, it was raised that e.g., socioeconomic models rely a lot on terrestrial data (e.g., agriculture data). A lot of this data is already being made available in other Digital Twin initiatives, and adding a copy of the data in EDITO might not be an optimal solution. A question was presented on whether these different Digital Twins will be made interoperable to avoid this problem, since there seems to be some confusion in the community regarding where to store a specific type of data. The development team responded that while cloud storage cost is often a barrier for data sharing, it is now being offered through these different Digital Twin initiatives, including EDITO. Other aspects are the security, quality control and licensing of the data, with a reminder that it is up to the data provider to define those.

From the perspective of a web developer using Copernicus Marine and EMODnet web service, a question was raised on the possibility of users developing front-end applications to be able to create their own APIs, based on Copernicus/EMODnet products. This was confirmed as a possibility already available in the platform, however with no specific use cases as yet that could be showcased. It was highlighted as a desirable contribution to be sought from beta-testers during the beta-testing phase. Regarding the beta-testing phase, participants suggested that EDITO organises communications around specific services, allowing users to report issues and provide feedback. It was confirmed that this is in the pipeline for the next phase of EDITO, which will continue to facilitate interactive user engagement. Another issue raised in connection with API development was the need to have security measures in place to properly manage usage traffic. The EDITO development team clarified that at the moment, contributions such as e.g., API development is not fully open, and services and processes that are contributed are being curated before they are published in the EDITO catalogue. When someone creates an API, they are responsible for it (and for configuring authorization to it) and the cost for its usage is on them. Currently, user quotes are applied. In case these need to be increased, an assessment is made on whether the specific kind of API in question should run within the EDITO platform or not. In this sense, it was noted that some work is still needed to establish procedures.

There was a discussion on the strategy towards "machine learning" training (i.e., whether users will need to provide pertained models to run as EDITO services, or whether the models could be trained on the infrastructure itself). The development team explained that some of these issues are being currently discussed and still need to be better defined. Currently, EDITO offers models that have been pre-trained offline. However, EDITO has connections with big HPC centres that could make it possible to train models on the infrastructure. They also have a bridge capacity to connect the data lake to other computing centres.

Addressing the visualisation needs of non-expert stakeholders engaged in co-designing decision support tools was also raised. Currently EDITO has two visitation tools on the platform, namely:

- One viewer is derived from the previous Copernicus Marine platform, showing now Copernicus Marine and EMODnet data together, but it will evolve over time based on user needs.

- Another viewer is geared at integrating data, so that users can create their own data and visualise it.

There may be specific visualisation needs for specific applications, and therefore the EDITO platform relies on the contributors to make their own visualisation tools available.

In short, participants contributions and recommendations can be summarised around the following topics:

**Additional data needs**

- Atmospheric data will be relevant for many of the what-if scenarios and applications people will run on EDITO.
- Need for guidance on what data should go into which Digital Twin to avoid duplication of efforts and how digital twins can be made interoperable.
- Citizen science has a lot of potential to become the next big resource for ocean observation which should go into EDITO (this will have challenges: e.g. GDPR).
- Many applications will need specific local data not yet offered by current data services.
- Users need to be able to trust the data that is made available, so quality control is key.

**User interaction**

- Need for feedback possibilities so that users can provide input on their needs.
- Data providers need analytics of data usage so they can show the impact of their data.
- Prototypes and what-if scenarios need to demonstrate the potential of EDITO to engage new users.

**Computing resources and functionalities**

- Procedures and cost model need to be developed on how to deal with API's that can have a lot of traffic.
- Visualisations should be developed by contributors to EDITO users rather than a single one-fits-all tool like the current viewers.
- Offering pre-trained models vs training large models on the platform. A strategy needs to be developed to see what is possible within the resources of EDITO.

## 3.3. BREAKOUT SESSION 2: Connecting an interoperable and cohesive network of digital twinning initiatives and applications via EDITO

**Rapporteur:** Lillian Diarra, MOi

### 3.3.1. Session objectives and topics covered

The session served to discuss the current capabilities offered by EDITO and collect feedback from participants on how to further evolve them to ensure that EDITO is interoperable and can deliver on its role as "connector" of the wealth of digital twins, initiatives and applications that will shape the European Digital Twin Ocean.

The session was chaired by Marine Tonani, the EDITO-infra project manager at Mercator Ocean International. To open the session, participants were asked to describe in one word what interoperability means to them via slido and the results centred on the notion of sharing, harmonisation and standards, saving time, and ensuring easy access (see Image 4).
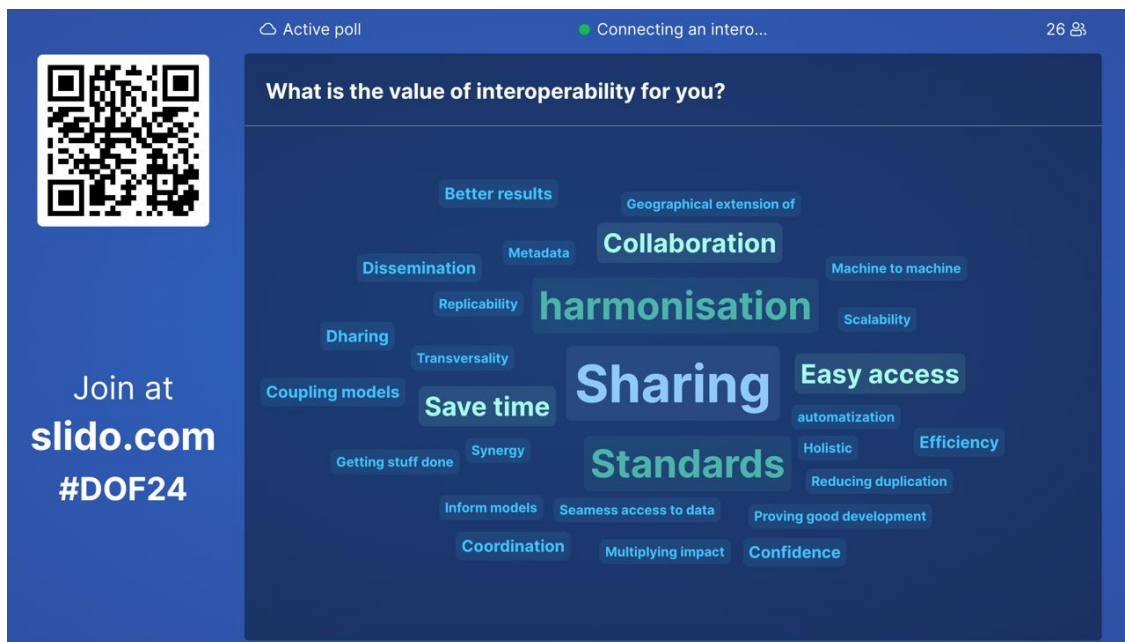


**Image 4.** Results of poll launched during Breakout Session 2

To set the stage, four short presentations were delivered by Thomas Dabrowski (Marine Institute), Pedro Montero (INTECMAR Galicia), Piotr Zaborowski (Open Geospatial Consortium - OGC) and Rutendo Musimwa (VLIZ).

Thomas Dabrowski presented the BIODIVER-COAST, a coastal service implemented by the Marine Institute (Ireland) and NOW systems (Spain), supported by the Copernicus User Engagement Programme. The main goal is to map suitable habitats for oyster aquaculture in the Galway Bay. The service uses an operational coastal model system to forecast low salinity events that have a negative impact on oyster mortality, disseminating information through a specific User Interface platform (NAUI@Galway) to support sustainable and ecologically responsible aquaculture and biodiversity preservation in the Galway Bay. Integrating into EDITO would allow for a faster service and extension of the service to new geographical locations (scalability and replicability).

Pedro Montero presented INTECMAR, a public institution under the Galician regional government, tasked with coastal operational oceanography for marine environment monitoring, studying shellfish pathologies and combating marine pollution. The institute also contributes to ocean prediction and data sharing services for the region. Its marine sciences programme is developing an integrated marine data platform, combining new technologies and tools for observing and monitoring the marine environment with a multi-scale interdisciplinary marine simulator, including socioeconomic aspects.



**Image 5.** Participants during Breakout Session 2

Piotr Zaborowski introduced OGC, a consortium of experts committed to improving access to geospatial, or location information and making it FAIR. The consortium is composed of over 480 members, supports collaborative solutions and innovations, adoption of good practices and standards to integrate into applications, and certified implementation of data products. Interoperability and standards developments within EDITO will thus be interesting for OGC.

Rutendo Musimwa presented her work on ecological modelling, particularly focusing on how she is exploring species habitats using EDITO. She explained that EDITO enables data access to the Copernicus Marine and EMODnet catalogues, processing (modelling, validation) and generating outputs, such as shared interoperable models, and that one can visualize modelled habitats and perform "*what-if*" scenarios and analysis. She argued that interoperability of models is crucial for gathering feedback and continual improvement.

These initial contributions were followed by discussions centred on the following topics:

- The value of interoperability to projects and initiatives.
- Challenges experienced when applying standards.

- How to onboard local digital twins and initiatives on EDITO in a way that ensures a "win-win" collaboration.
- How to develop and enforce new standards to address outstanding challenges for a fit-for-purpose European Digital Twin Ocean, e.g., heterogeneity of socio-economic data.
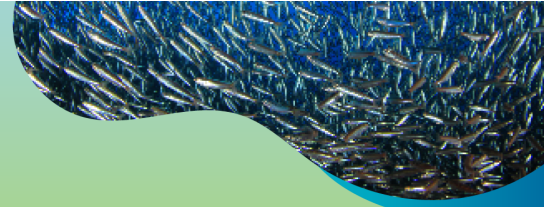
### 3.3.2.  Main topics of interest, key messages and recommendations

The discussion started with participants reflecting on challenges experienced when applying standars. Some of the main challenges highlighted included motivation and resources (e.g., financial cost, time) to ensure the development and implementation of standards and best practices and interoperability from the start of a project/service. Participants highlighted that applying standards is a long-term investment, and that it is a necessary condition for effectively and consistently sharing data, information and models. In terms of the EDITO platform, leveraging standards is crucial to build a thriving digital ocean knowledge system.

A participant stressed the importance of interacting with the community to evolve standards, giving the example of the eDNA data and ongoing efforts towards common metadata (referring to the European Nucleic Archive, and ongoing projects looking into addressing the gaps and lack of interoperability in environmental DNA data in the aquatic community, encompassing over 4 million records).

Participants identified several opportunities to strengthen interoperability:

- **Leveraging EDITO:** There is the need to avoid silo systems, however it is very costly to implement operational interoperable systems. EDITO is an opportunity to overcome this partly and today offers some extent of operability, allowing to mix and match software. The big five tech companies work well with this approach and now the EU sector is starting to align to this vision.

- **Ensuring collaboration between large initiatives:** Efforts are not optimised when services/systems are created but are not usable to the outside community. Large initiatives need to collaborate to ensure interoperability (e.g. EDITO and DestinE), onboard mutual, existing users and enhance their interfaces.

- **Ensuring continued collaboration with other EU DTO projects:** For a large-scale project (e.g., H2020 Iliad) which is building multiple digital twin applications composed of various parameters, interoperability is pivotable and completely necessary. It is an economic issue, being able to reuse components across different thematic teams.

- **Learning from Earth Observation (EO) services**. Collaboration is key and in terms of data catalogues, meta data availability needs to be scaled up and the integration of data services. However, there is a gap in the definition of services and in general it is hard to define models, but the marine community can learn from what has been developed for EO services.

- **Automation of processes of adding metadata and other information**: In the EDITO platform, metadata can be extracted from data itself. The process of adding metadata could be automated – for example, users could be prompted to add certain information as they upload data, and processes could be put in place to ensure users are compliant with standards, and in general improve the user experience.

- **Further support international alignment and cooperation:** Copernicus Marine and EMODnet are working with the international community already to ensure standards,
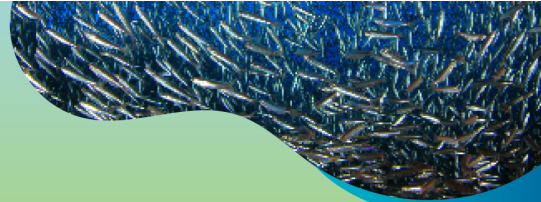
which are being integrated in EDITO, but this needs to go further as new data sources are added and to describe services/applications.

- **Building an integration layer for conversion/standardization.** Participants raised that a conversion/standardisation layer is yet missing for oceanography. Standards need to be imposed by authoritative standard mapping in the ETL process and guided by international mandates. The Ocean Data 2030 programme sets out to progressively deepen interoperability – starting with key metadata and working towards more domain-/community-specific types.

- **Links with EOSC**: Possibility of EDITO becoming an EOSC node in the future.

Reflecting further on current challenges, participants mentioned:

- **Lack of standards for and interoperability with social data:** It is costly to follow standards, describe data well and incentives are needed to move away from publish or perish, to put some work into establishing and implementing standards. This is lacking for social data, but with the direction of digital twinning with onset of new projects (such as SURIMI and others looking to develop socioeconomic models and tools for the EU DTO), interoperability with data, models and services from the socioeconomic sphere will be crucial. "*If we can represent the currents, the temperature and the fish, we will have to represent people*", one participant argued.

- **Lack of incentives and long-term support to develop interoperability:** Interoperability takes time, and so does establishing standards for different parameters (from biological to socioeconomic). There is a lot of work to be done to convince others that this is crucial, as it will not lead to more publications or funding. But at the end of the journey, it was largely agreed, it has to be done.

- **Ocean carbon** is a topic not adequately addressed. Currently, the fact that EDITO only includes the EMODnet and Copernicus Marine catalogues can be limiting, and there is a need to widen this coverage by including additional data sources and a global outlook, including linkages from local to regional to global scale. Participants pointed at e.g., some data flows into ODIS that will be created working with SOCAT and GOOS. EDITO could potentially integrate this data into its own environment.

- **Lack of interoperability between freshwater and sea systems:** When users work with multiple data sources (models, in situ data from different platforms, from different countries, EU and non-EU) interoperability is key. Understanding river sea systems, the water continuum - from river to estuary to sea, requires harmonisation of standards. This is very challenging and needs to be addressed. There is need for a standardisation layer for standards coming from different communities to be able to effectively codify how to provide information outside a specific community.

- **Lack of collaboration with communities delivering the data:** The example of looking for gaps in environmental DNA in the aquatic community shows major lack of interoperability, given over 4,3 million records that need to be cleaned, stressing importance of interaction with community delivering data.

Participants contributions to be considered in the further development of EDITO, include:

- Interoperability is key for sharing and collaboration, seamless data and model access, replicability, scalability, reducing duplication of efforts, gaining more users and increasing impact outside the core EDITO community.
- Need for buy-in by all stakeholders to see value and necessity of interoperability.
- Need for long-term investment (funding, time, other resources).
- Need for interoperability with other systems (freshwater systems, atmospheric, land, socioeconomic) and initiatives (e.g. DestinE, H2020 Iliad digital twin applications, etc.).
- Develop standards with EU and international relevant bodies (e.g., the Ocean Data 2030 programme, EOSC, OGC, etc).
- Need a standardisation layer for standards coming from different communities.
- Need to interact with communities delivering the data in setting standards.
- Implement automated processes to prompt users to add specific metadata/information when uploading their data and models to the platform. Improve the user experience by automatically putting this information in standardized formats.
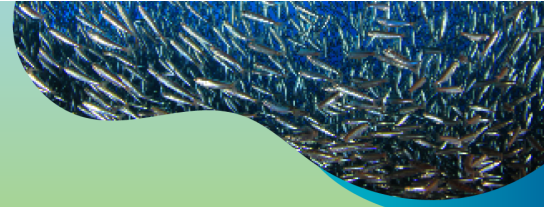
## 3.4. BREAKOUT SESSION 3: Delivering to policy objectives: A vision for the European DTO

**Rapporteur:** Vicente Fernandez, Seascape Belgium

### 3.4.1. Session objectives and topics covered

The key objective of this session was to discuss how **EDITO** -the public infrastructure of the European Digital Twin Ocean-, should evolve to (1) ensure that the European Digital Twin Ocean can deliver the knowledge required to address the policy objectives of the EU Mission "Restore our Ocean & Waters by 2030", and (2) align with other international initiatives and developments, to contribute to co-create the knowledge required to support the delivery of the **UN Agenda 2030** and the **UN Decade of Ocean Science for Sustainable Development**, globally.

The session was Chaired by Julia Vera (Seascape Belgium), who firstly presented the session objectives, including an outline of the questions that were open for discussion during the session:

- What priorities should guide the co-creation of the European DTO?

- How do we bring communities together to build the European DTO, leveraging EDITO, so that it effectively evolves to deliver the knowledge required to address policy challenges at local, national, European, and international level?

- What role can public-private cooperation play in shaping a fit-for-purpose European Digital Twin Ocean?

- What incentives are needed to achieve a fit-for purpose DTO?

- How can EDITO support alignment of the European Digital Twin Ocean with other international initiatives, to address wider policy objectives?

She then introduced the guest speakers that had been invited to deliver initial contributions, giving them the floor to kick-start the conversation with participants.

Maurice Heral (Sustainable Blue Economy Partnership - SBEP) gave a short introduction to the Sustainable Blue Economy Partnership (25 countries represented at European level), which is funding the development of digital twins at sea-basin level. He explained SBEP's approach to investment in digital twinning projects via yearly open research calls, criteria including:

- Building clusters of projects dealing with cross-cutting thematics, including sustainable fisheries, greening aquaculture, offshore windfarms, energy transition and Maritime Spatial Planning (MSP).

- Leveraging EDITO to host and manage the portfolio of Digital Twins applications, which rely on EMODnet and Copernicus data.

- Prioritising projects that respond to policy objectives (e.g., MSP, MSFD, WFD, MPAs), providing tools for policy makers, and to act as "one arm" of the Mission "Restore Our Ocean and Waters" Lighthouses, and working from a local scale, but with a vision to add towards a regional one (e.g., connecting countries that share an approach to MSP; using digital twins to design MPAs for specific species, etc).
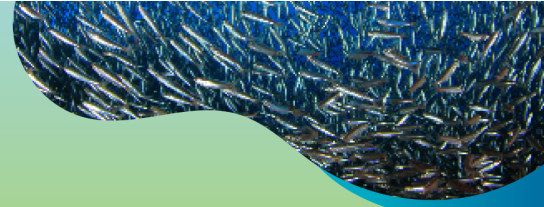
Heral emphasized that the use of EDITO ensures interoperability of efforts, while collaboration with the Intergovernmental Oceanographic Commission of UNESCO (IOC-UNESCO) ensures alignment with relevant international efforts.

**Image 6.** Participants during Breakout Session 3

Louis Demargne (IOC-UNESCO) offered a short introduction to Challenge 8 of the United Nations (UN) Decade of Ocean Science for Sustainable Development ("Ocean Decade"), which aims to create a digital representation of the ocean. He referred to the key messages emerging from the Vision 2030 White Paper on "Ocean Data-sharing", which outlines the components of the "enabling environment" that the Vision asks to deploy as a necessary means to produce a digital replica of the ocean, namely (1) initial digital content (i.e.,data, data products, information); and (2) tools/services, including a distributed backbone data and information infrastructure (i.e., global distributed Data Discovery and Access Service via ODIS), a distributed ocean forecasting service, and a digital atlas. Demargne argued that through its enabling infrastructure, EDITO is contributing to this framework with European capabilities. However, he pointed at the need to further incentivize data sharing across disciplines and nations, as a key to delivering on Challenge 8, and maximise the potential of available infrastructures, such as EDITO. The more data that flows into the data lake of these infrastructures (including via existing aggregators), he argued, the better the information products that will emerge, to support policy and decision making. He emphasized that incentives are needed to engage industry in sharing the data it collects, pointing at the benefits associated with contributing and participating in these efforts (e.g., better information products, more accurate models, reduced downtime, reduced costs), as well as to engage with national governments. He explained that certain datasets are perceived to be strategically sensitive, so that (mandatory) policies might have to be put place so that this data is more timely available. On a similar way, incentives are needed to onboard industry in digital twinning efforts. Industry representatives need to be convinced that, by becoming a partner with e.g., EDITO, they can help to influence the tools (e.g., models, applications, etc) that are built by the community and offered as a service via the European DTO, so they receive a return that is

useful for their purpose. Industry can also bring efficiency in developing tools and applications. The idea is not to tye in the digital twinning ecosystems with proprietary software, but rather to the contrary, leveraging EDITO's approach (deploying open data, open software, open standards) to onboard industry in developing win-win applications. On another front, he argued that while infrastructures like EDITO can service the community by enabling an ecosystem that makes information more easily consumable by non-experts, the community requires to be shaped by data savvy individuals (with knowledge and skills e.g., on data management, etc). Therefore, infrastructures such as EDITO should also serve as training tools that enable better capacity of knowledge, skills, and competences on data management, use, analyses, and exploitation or marine data.

Elías Pinilla (Chilean Ministry of Economy, Infrastructure & Tourism) gave a short introduction to CHONOS, which is a science-based tool intended for decision making for the National plan of the Chile Administrations, providing xamples on how (real time) data products and forecasts are applied to aquaculture endeavors. Aquaculture is an important sector of the "blue" economy in Chile, being the 2nd largest producer of aquaculture products in the world. He gave examples of how CHONOS is used to predict Harmful Alga Blooms (HABs) with a potential effect on aquaculture, or to optimise the location of aquaculture farms. The regional forecast system is using Copernicus Marine global as boundary conditions for the regional system. Reflecting on how to ensure that digital twinning efforts contribute to support policy objectives, he highlighted the need to address the "gap" or distance between scientists and decision-makers, pointing at the importance of co-creating tools with a good understanding of the needs and expectations of its target users, so that these tools are user-friendly and fit-for-purpose. He also highlighted the need to include more socioeconomic variables into digital twins, to make sure that the information is relevant for policy makers.

After these initial contributions, participants were invited to share in the discussion.

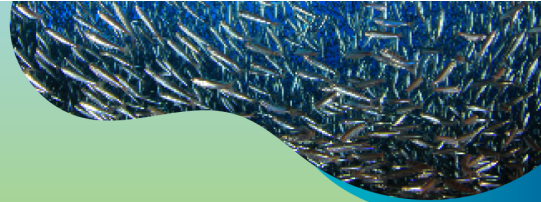### 3.4.2. Main topics of interest, key messages and recommendations

Initial participant contributions on defining priorities for the evolution of the European DTO referred to the need to work with a focus on the needs of end-users, and thus ensure a user-driven roadmap of developments. On this front, it was argued that while marine science and technology are rapidly progressing, the use of this science and technology in decision making across environmental policy is still lagging behind. The "science-to-policy" interface was suggested to be failing (both to policy and to citizens). Digital Twins can play a key role in solving this, but participants also agree that we are not there yet. Also, it was argued that there was a need to re-frame "environmental (policy) challenges" as economic and social challenges, to gain buy-in from decision-makers and end-users of digital twinning applications. Participants argued that what happens to the ocean is very relevant to people's life and livelihoods, and that therefore this message should be central when seeking to onboard citizens and other stakeholders in ocean management and governance, highlighting the benefits of e.g., achieving coastal resilience, cost savings, better health, etc. Co-creating relevant "*what-if*" scenarios and/or decision-making tools with stakeholders is a must towards this end. There are existing networks (e.g., the Coalition of Mayors for Mission Ocean representing small coastal towns in Europe) who are in direct touch with the needs of their communities, but lack the capabilities, skills and resources to engage in digital twinning efforts. Bridging scientific and technical capabilities with direct insights into user needs would provide a thriving framework for the co-development of the European DTO, which has enormous potential as a tool enabling cooperation across stakeholders and disciplines.

The idea of identifying a "blockbuster" or "killer" application that could generate broad, societal interest in the European DTO was also presented and discussed, together with the idea of the first identifying clear "user needs", and then developing models and applications that directly deliver to those needs, rather than working the other way around (i.e., developing science-based solutions, and then trying to find problems that these can potentially solve, as it is often done).

The role of the European DTO as a tool geared at making information and decision-making more transparent and understandable to the general public was also discussed. Participants argued that the European DTO should strive to be an enabler of democracy, opening ways to enable direct participation by citizens on ocean management decisions and bring enhanced accountability to evaluate scientific outputs, as well as the choices of decision-makers. Although this was deemed as an ambitious vision, it was agreed that the European DTO should be developed with high aims, following a staged approach to progressively move towards such vision. The need to ensure broader and closer engagement of the private sector towards this end, including industry, was further emphasized.

Participants contributions to be considered in the further development of EDITO and the European Digital Twin Ocean, include:

- **Addressing the "gap" between scientists and decision-makers:** The importance of creating framing incentives to ensure that the tools and applications that are built leveraging EDITO towards co-creating the European DTO are developed with a good understanding of the needs and expectations of target users, from the beginning of the co-creation process.
- **Engaging with local communities and governments**, e.g. cities, as a way to understand and better scope the needs of users (i.e., "*ask questions first, then build applications*"). Look for ways of addressing the specific needs of coastal communities, connecting software developers with local representatives, including decision-makers, policymakers, or regulators, so they can inform existing needs.
- **Working on "killer" applications:** Find tools or applications that could increase the uptake of the European DTO.
- **Ensuring the integration of socio-economic data into Digital Twins**, including re-framing environmental challenges or scientific issues as socioeconomic challenges.
- **Making marine information and knowledge more accessible and understandable to the public.**
- **Incentivizing data sharing:** Engage industry, highlighting what they will get back from contributing and participating in these efforts (e.g., better information products, more accurate models, reduced downtime of operations, cost savings, etc). Engage scientists, and improve the accountability of science, in order to make marine data more reliable and trustful.
- **Ensuring the availability of data at all scales:** Move from being "data rich" at national and regional level, to being "data rich" also at local level.
- **Supporting capacity building efforts around data related topics:** To enable an ecosystem that is capable of making information more easily consumable by non-experts.

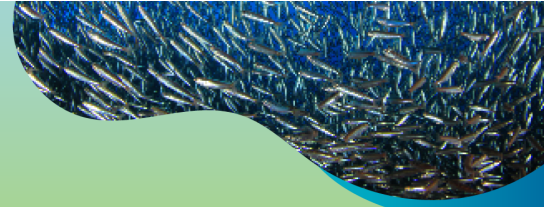## 3.5. The Road Ahead: Key outcomes & messages from the community

This last session featured key messages from the three Chairs of the Breakout Sessions (Klass Deneudt, Marina Tonani, and Julia Vera, from VLIZ, MOi and Seascape Belgium, respectively) and closing remarks from the European Commission, MOi and VLIZ.

As described in preceding sections, Breakout Session 1 discussed the EDITO Data Lake, highlighting the need for relevant atmospheric data, citizen science, and flexible visualizations. Breakout Session 2 emphasized the value of interoperability, standards, and cross-community collaboration. Breakout Session 3 focused on aligning digital twin objectives with policy and societal needs, stressing the need for a co-creation approach and close engagement with policymakers and local governments, as well as the private sector.

In closing, Nicolas Segebarth from the European Commission announced plans to scale up infrastructure capacity and resources in support of further EDITO and European DTO developments, by early 2025.



**Image 7.** DOF2024 participants

#MissionOcean   #DOF2024
#EUDTO   #edito_dto

## 4.   Proceedings from the High Level Legacy Event

The annual Digital Ocean Forum took place on 13 June 2024 in Brussels under the auspices of the Belgian presidency of the Council of the European Union (EU), organised by the European Commission with support from Mercator Ocean International, the Flanders Marine Institute (VLIZ) and Seascape Belgium.
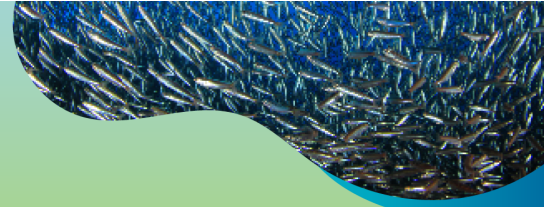


**Image 8.** Highlights from DOF2024

This third edition was pivotal with the unveiling of the pre-operational platform of the European Digital Twin Ocean (EU DTO), showcasing concrete applications and contributions from other digital twinning initiatives. Over 200 participants attended the event with 100s more online, representing the European Commission, international organisations, national, regional, and local governments, and research institutions, academia, blue economy industry and SMEs, and civil society.

### 4.1.   Opening keynotes

DOF2024 opened with keynote speeches notably from Iliana Ivanova, EU Commissioner for Innovation, Research, Culture, Education, and Youth, Johan Hanssens, Secretary General of the Flanders Department for Economy, Science, and Innovation, Pascal Lamy from the EU Mission Restore Our Ocean and Waters and Olivier Poivre d'Arvor from the French Ministry of Europe and Foreign Affairs. Each speaker brought valuable insights into the multifaceted efforts required to advance ocean sustainability and the potential role of the European Digital Twin Ocean to achieve this.

### 4.2.   Demonstrating the core infrastructure of the European Digital Twin Ocean

Kestutis Sadauskas, Deputy Director-General of the DG MARE set the stage for the demonstration of the EU DTO prototype (EDITO), emphasising the collaborative efforts and significant progress made over the past two years to deliver this unique core infrastructure. This strong foundation will pave the way for future advancements, enabling the marine community to build on this knowledge and create tailor-made applications, providing a new page in ocean and coastal management. Pierre Bahurel from Mercator Ocean International introduced the EDITO platform, delving into its founding principles, cutting-edge capabilities and offer. This was followed by three concrete applications targeting marine pollution tracking, using natural based solutions against coastal hazards, tracking marine fauna for marine biodiversity conservation. These demonstrations illustrated the platform's capacity to support the scientific community, environmental managers and policymakers in addressing critical environmental challenges through innovative digital solutions.

#MissionOcean   #DOF2024
#EUDTO   #edito_dto

## 4.3.   Short pitches from community of projects

The event also featured TEDx-like pitches from innovative digital twin projects selected through a call for expressions of interest. Each speaker addressed how their application can support marine biodiversity, coastal resilience, climate adaptation and a sustainable blue economy, among other topics in line with the Mission Ocean. These presentations showcased the practical applications of digital twin technologies, highlighting the value added by integration in EDITO such as scalability, replicability to other regions, fast processing speeds, and integrated access to data.

## 4.4.   A community vision

The afternoon sessions were dedicated to fostering a community vision for the EU DTO, starting with a keynote by Gustav Kalbe - Acting Director-General for DG Connect, who emphasized the collaborative efforts and technological advancements that have made the EU DTO possible. Other interventions included speeches by Florika Fink-Hooijer - Director-General for DG Environment, Mauro Facchini, Head of Unit for DG DEFIS, and Nadia Pinardi from the University of Bologna representing the Decade Collaborative Centre for Coastal Resilience. These interventions not only highlighted the joint efforts within the European Commission and EU marine science community to build the EU DTO but also the diverse cross-cutting challenges that the EU DTO can be used to address and linkages with other initiatives such as DestinE and the DITTO Ocean Decade programme.

This was followed by panel discussions bringing together different actors and stakeholders to speak about the EU DTO's future vision, including interoperability, integration of multidisciplinary data, inclusion and societal and ethical aspects.

The day wrapped up with a closing address by John Bell, the European Commission's 'Healthy Planet" Director who emphasised the collaborative efforts needed to achieve the ambitious goals set for the oceanic digital frontier – *__With the launch of this DTO, we're not just turning on a switch on an interesting digital project; we're turning the lights on in the ocean and our future.__*"

For replays of the event, information on the EDITO demo, use cases, photos and more, visit https://events.edito.eu/2024-digital-ocean-forum

**Also see:**

- European Digital Twin of the Ocean (European DTO) - European Commission (europa.eu)

- "European Digital Twin Ocean: A game changer for policymakers, coastal communities & society" (video)

- **EDITO offer:** https://events.edito.eu/2024-digital-ocean-forum/content/eu-dto-platform
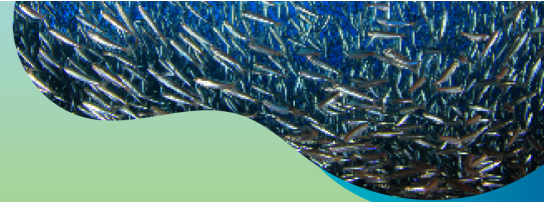
## 5.   Conclusions

The 3rd edition of the Digital Ocean Forum took place in Brussels on 12-13 June 2024. The event successfully brought together a large community of EU research projects and national initiatives to share, assess, and discuss the current status of EDITO, the prototype infrastructure of the European DTO, which is currently available in beta-testing mode. It served to showcase the benefits that this infrastructure brings to society in general and to existing consortia in particular, playing a key role in supporting the community towards co-creating the European DTO, as well as further identifying expectations and recommendations from these expert communities.

While the High-Level Event underscored the social significance of the European Digital Twin Ocean and showcased its potential with the unveiling of its prototype infrastructure, the Scientific & Technical Workshop offered guidance to continue making progress towards an operational, fit-for-purpose EU DTO. Overall, more than 60 EU projects representing scientists, users, and ocean communities offered insights and suggestions. Specifically, key technical highlights for consideration include:

**On EDITO Data Lake & Modelling Engine:**

- EDITO data lake will benefit from integrating atmospheric, carbon, and freshwater data. Atmospheric data, especially, will be relevant for many of the "what-if" scenarios and applications that intermediate and/or end-users will want to run on EDITO.
- High resolution, quality controlled data should be the aim for EDITO's data lake.
- Citizen science has a lot of potential to become the next big resource for ocean observation. Citizens, local governments and industries can play a key role in this regard, submitting their data at high resolution.
- Data providers welcome analytics of their data usage and this is an incentive for them to continue sharing data.
- EDITO should continue to offer prototypes of applications and "what-if" scenarios to demonstrate the potential of cloud-based technologies.
- Procedures and costing models are need for API's that can result in generating a lot of traffic on the infrastructure.
- Visualisations should be developed by contributors to EDITO, rather than a single one-fits-all tool as the one offered by the current viewer.
- Computing resources can be saved by providing pre-trained models, instead of allowing every user to train their own models on the platform.
- Deploy better solutions to collect metadata, such as partly automated systems that collect automatically, and let data providers provide the rest by filling a simple web form.

**On interoperability:**

- Interoperability is key for sharing and collaboration, seamless data and model access, replicability, scalability, reducing duplication of efforts, gaining more users and increasing impact outside the core EDITO community.
- There is a need for guidance regarding what data should go into which digital twinning initiative or infrastructure to avoid duplication of efforts, and on making digital twins interoperable.
- Need for buy-in by all stakeholders to see value and necessity of interoperability.
- Need for long-term investment (funding, time, other resources).

- Need for interoperability with other systems (freshwater systems, atmospheric, land, socioeconomic) and initiatives (e.g. DestinE, H2020 Iliad digital twin applications, etc).
- Need a standardisation layer for standards coming from different communities, and to interact with communities delivering the data towards setting standards.
- Implement automated processes to prompt users to add specific meta data/information when uploading their data and models to the platform. Improve the user experience by automatically putting this information in standardized formats.
- Complete interoperability is challenging and there will always be the need for integration components such as adopting standards. These are time-consuming tasks and skepticism should be expected: we need to better communicate the benefits of adopting standards

**On supporting the long-term, community vision for the European Digital Twin Ocean:**

- The European Digital Twin Ocean should be instrumental in enabling and offering a well-functioning "science-to-policy" interface. EDITO can pave the way forward by supporting applications that contribute to this end, and by prioritizing the integration of *"what-if"* scenarios and/or decision-making tools that have been co-created by developers by engaging with user communities.
- There are existing networks (e.g., the Coalition of Mayors for Mission Ocean) who are in direct touch with the needs of their communities, but lack the capabilities, skills and resources to engage in digital twinning efforts. Bridging scientific and technical capabilities with direct insights into user needs would provide a thriving framework for the co-development of the European DTO, which has enormous potential as a tool enabling cooperation across stakeholders and disciplines.
- The European DTO should have the ambition of becoming an enabler of democracy, opening ways to enable direct participation by citizens in ocean management decisions and to bring enhanced accountability in the evaluation of scientific outputs, as well as of the choices of decision-makers.
- Engaging the private sector, including industry, in the co-creation of the European DTO is key to its success, offering opportunities for enhancing the availability of data, but also for a more efficient development of fit-for-purpose applications for better decision making in support of economic, environmental and societal objectives.
- Investing in "data" capacity building is a necessary condition to deliver an enabling environment that can make information more easily consumable by non-experts.

As EDITO continues to evolve building on past[1] and on-going beta-user interactions, these conclusions will inform its technical roadmap and the next phase of development, which is planned to start in 2025.

---

[1] See DOF2023 Scientific & Technical Workshop Report:
https://assets.ctfassets.net/cdx728z92xkc/4uGhkkzOGnW5JCRJy6v6nc/d5345acb6158445d0baae6625a0925e9/ec_rtd_digital-ocean-forum-final-report.pdf

## 6. Annex

### 6.1. Agenda of the Scientific & Technical Workshop

# Digital Ocean Forum #3

Wednesday **12 June 2024**
**Scientific and Technical Workshop**    *Brussels, Palais des Académies*

## Agenda

| | |
|---|---|
| 12pm–1.30pm | **Registration & networking lunch** |
| 1.30pm-2pm | **Welcome!** *Auditorium Albert II* |
| | ▪ Elisabetta Balzi, Head of Unit "Ocean, Seas & Waters", DG Research & Innovation<br>▪ Remy Denos, Deputy Head of Unit "Maritime Innovation, Marine Knowledge & Investment", DG Maritime Affairs & Fisheries<br>▪ Alain Arnaud, EDITO-Infra coordinator, Mercator Ocean International (MOi)<br>▪ Francisco Hernández, Flanders Marine Institute (VLIZ) |
| 2pm-3.30pm | **Exploring the current capabilities of the EDITO platform** |
| | ▪ **Introducing EDITO:** Quentin Gaudel & Chloe Delpont Ramat, MOi<br>▪ **EDITO insights from early beta-testers:**<br>   Lőrinc Mészáros, Deltares · Mario Salinas, CMCC · Matteo Mikos, Seascape Belgium<br>**Chaired by:** Laurence Crosnier, MOi. **Rapporteur:** Salvador Fernández, VLIZ |
| 3.30-5pm | **Leveraging EDITO to co-develop the European Digital Twin Ocean**<br>*Stevin Room, Marie-Thérèse Room, Albert I Room* |
| | **Breakout Session 1: Exploring the EDITO Data Lake & Modelling Engine and addressing user needs: Challenges & opportunities** |
| | **Chair:** Klaas Deneudt, VLIZ. **Rapporteur:** Tim Collart, EMODnet Secretariat<br>**Contributors:**<br>▪ Laurence Crosnier, MOi<br>▪ Conor Delaney, Technical Coordinator, EMODnet Secretariat<br>▪ Patrick Gorringe, SMHI |
| | **Breakout Session 2: Connecting an interoperable and cohesive network of digital twinning initiatives and applications via EDITO** |
| | **Chair:** Marina Tonani, MOi. **Rapporteur:** Lillian Diarra, MOi<br>**Contributors:**<br>▪ Tomasz Dabrowski, Marine Institute<br>▪ Pedro Montero, INTECMAR Galicia<br>▪ Piotr Zaborowski, Open Geospatial Consortium<br>▪ Rutendo Musimwa, VLIZ |
| | **Breakout Session 3: Delivering to policy objectives: A vision for the EU DTO** |
| | **Chair:** Julia Vera, Seascape Belgium. **Rapporteur:** Vicente Fernández, EMODnet Sec<br>**Contributors:**<br>▪ Maurice Heral, Sustainable Blue Economy Partnership<br>▪ Louis Demargne, IOC-UNESCO<br>▪ Elías Pinilla, Instituto de Fomento Pesquero (IFOP Chile) |
| 5.15pm-6pm | **The Road Ahead: Key outcomes & messages from the community**<br>*Auditorium Albert II* |
| | ▪ Key messages & conclusions from Breakout Sessions: K. Deneudt, M.Tonani, J.Vera<br>▪ Closing remarks: European Commission, MOi & VLIZ representatives |
| 6pm-7.30pm | **Reception** - *Offered by the Flanders Marine Institute* |

#DOF2024
#MissionOcean
#EUDTO
#edito_dto

EU **MISSIONS** RESTORE OUR OCEAN & WATERS
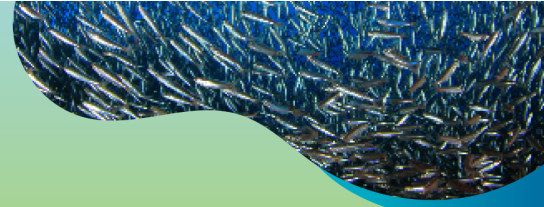
EDITO European Digital Twin Ocean *in cooperation with*

EU **MISSIONS** RESTORE OUR OCEAN & WATERS

EDITO European Digital Twin Ocean *in cooperation with*
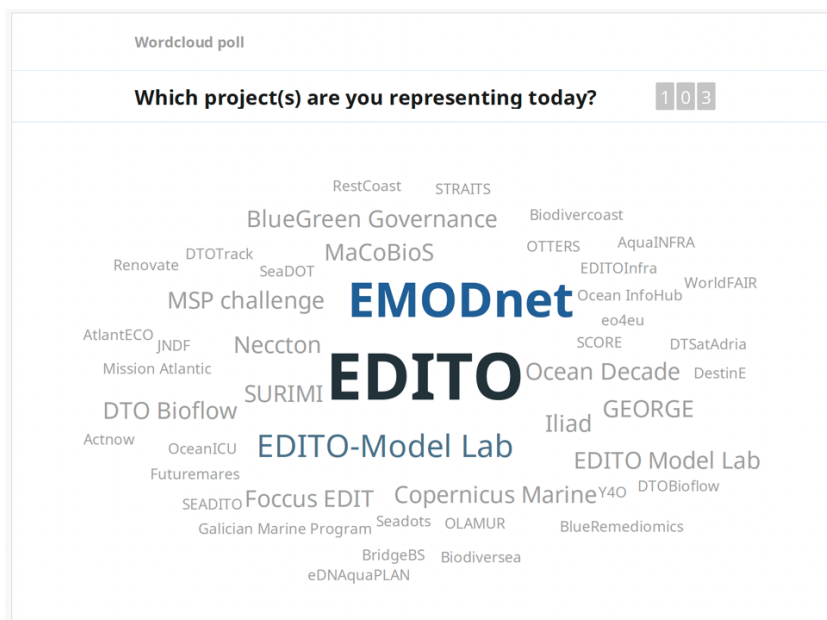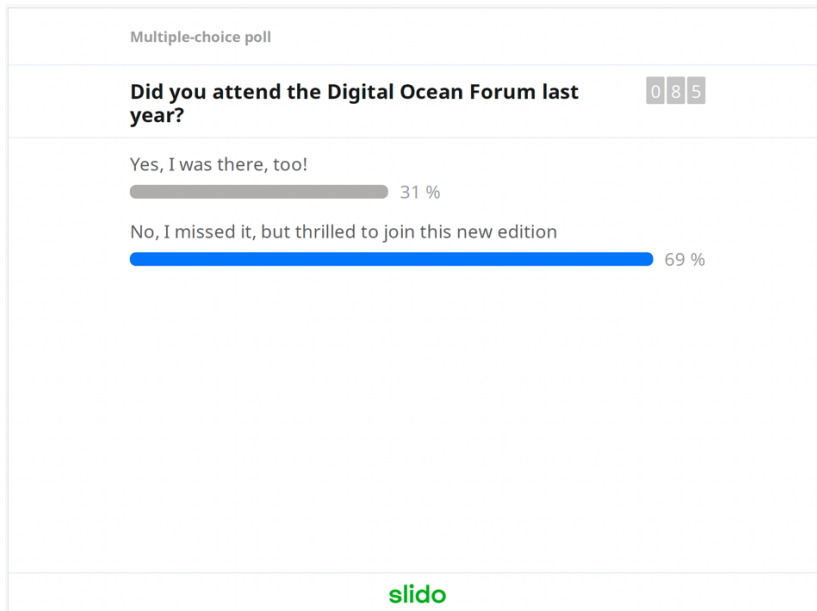
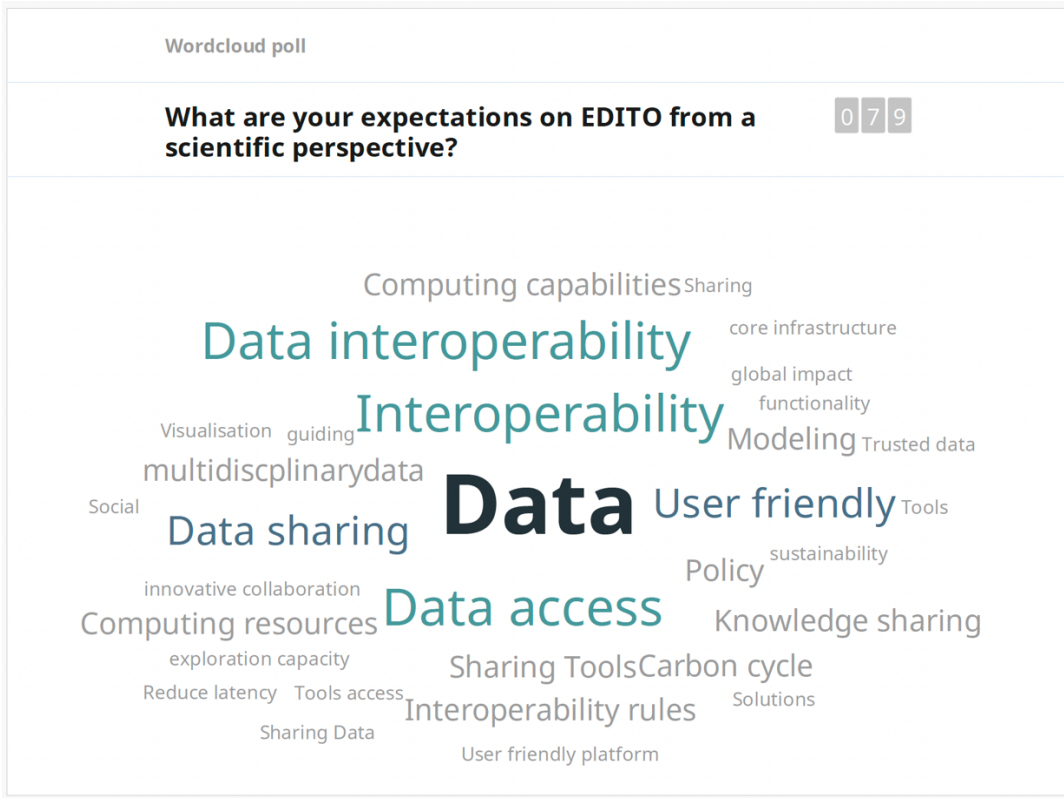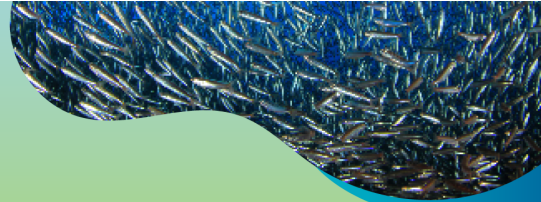#MissionOcean    #DOF2024
#EUDTO    #edito_dto

## 6.2. Results of polls launched during the Workshop

### 6.2.1. Welcome!

The audience was asked to respond to several polls throughout Breakout Session 1. The results are available in the images below.
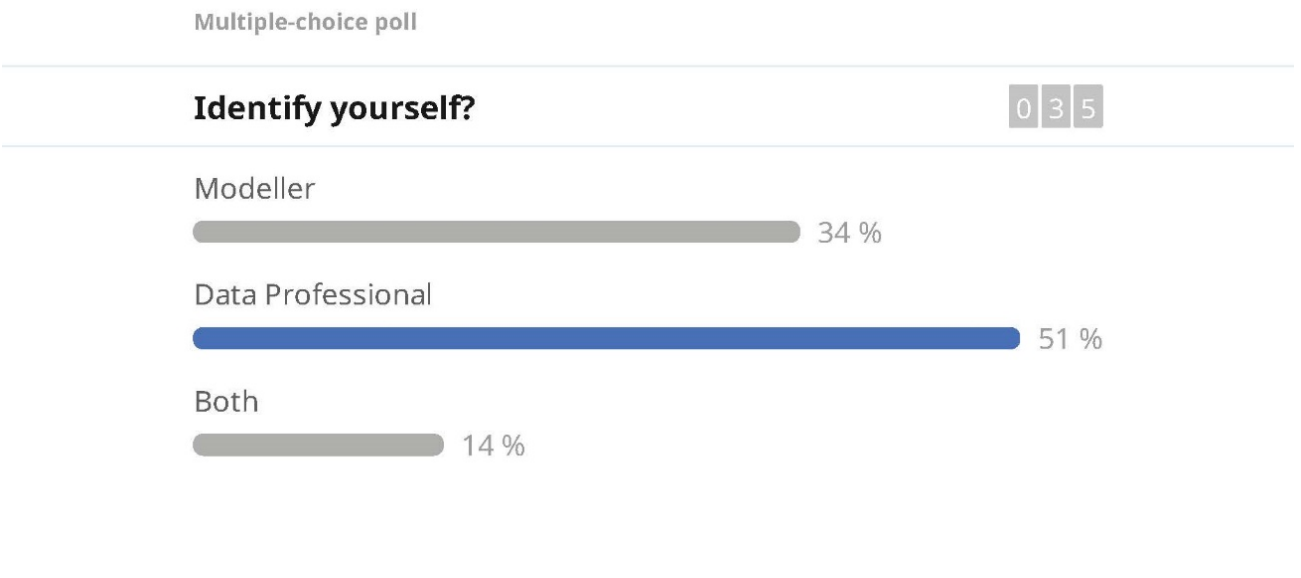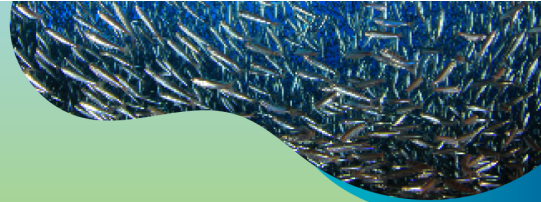
## 6.2.2. Breakout Session 1: results from Slido

The audience was asked to respond to several polls throughout Breakout Session 1. The results are available in the images below.

- Identify yourself?



- Have you used/tested the EDITO infrastructure already:

Multiple-choice poll

### Have you used/tested the EDITO infrastructure already?    `0` `3` `9`

Yes
49 %

No
51 %

- Do you have experience with other cloud platforms? (Yes/No)

Multiple-choice poll

### Do you have experience with other cloud platforms?    `0` `1` `3`

Yes
77 %

No
23 %

- What did you like the most about the EDITO infrastructure? (wordcloud)

Wordcloud poll

### What did you like the most about the EDITO infrastructure?    `0` `2` `1`

Excellent user interface
Cloud working environment
Freedom to create    Sharing    Cocreation
Abstract environment    POTENTIAL    Interoperability    Flabbergasting
Complexity    Creativity
FAIR    Innovatives
Interconnectivity    **Flexibility**    Free compute
Easytouse    The team    The potential    Its magic!
Participation    Creation
Participatory Process
Integration of platforms    Cloudy
Back-end capabilities

- What do you think is the bigger challenge?  (two options: computation or data storage)
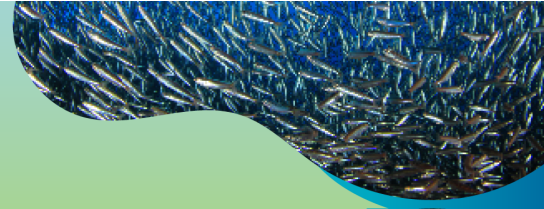
Multiple-choice poll

### What do you think is the bigger challenge?   0 3 1

Computation                                          71 %
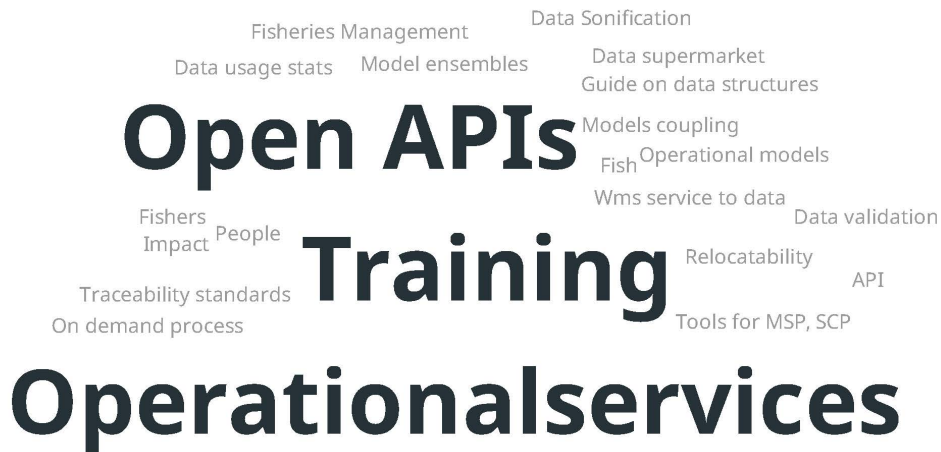
Data Storage                        29 %

- If there is a feature that you would like to see developed, what would that be? (wordcloud)
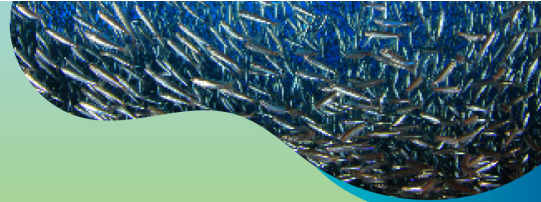
Wordcloud poll

### If there is a feature that you would like to see developed, which one would that be?   0 2 3



**Editor note:** EDITO already has Open API's

- EDITO will offer a selection of datasets. What datasets are according to you indispensable? (wordcloud)

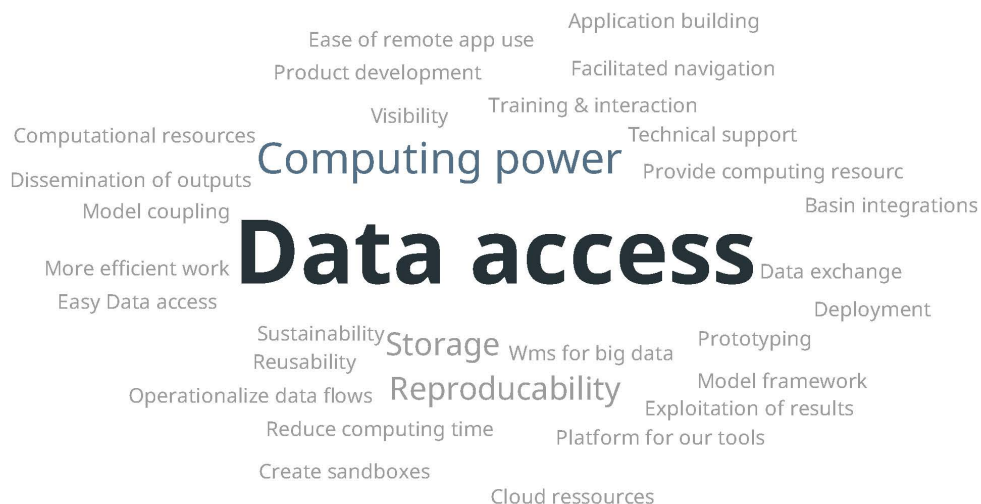- How would you see the process of user engagement? What elements are crucial? (wordcloud)



- Most of you are involved in EU projects. How will the EDITO infrastructure help out with your projects? (wordcloud)
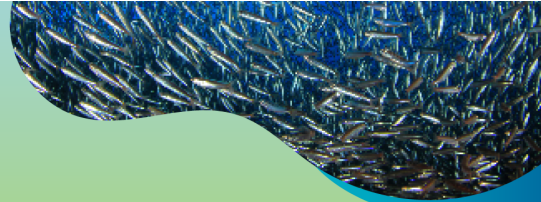
Wordcloud poll

**Most of you are involved in EU projects. How will the EDITO infrastructure help out with your projects?** 0 2 5

Ease of remote app use
Application building
Product development
Facilitated navigation
Visibility
Training & interaction
Computational resources
Technical support
Computing power
Provide computing resourc
Dissemination of outputs
Model coupling
Basin integrations

## Data access

More efficient work
Data exchange
Easy Data access
Deployment
Sustainability
Storage
Wms for big data
Prototyping
Reusability
Operationalize data flows
Reproducability
Model framework
Exploitation of results
Reduce computing time
Platform for our tools
Create sandboxes
Cloud ressources

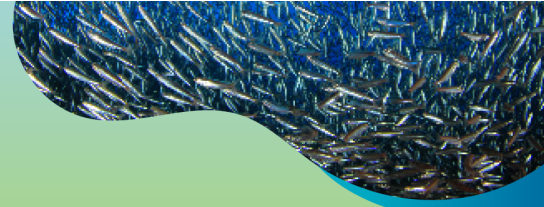#MissionOcean #DOF2024
#EUDTO #edito_dto

### 6.2.3. Breakout Session 2: results from polls

The audience was asked to respond to several polls throughout Breakout Session 1. The results are available in the images below.
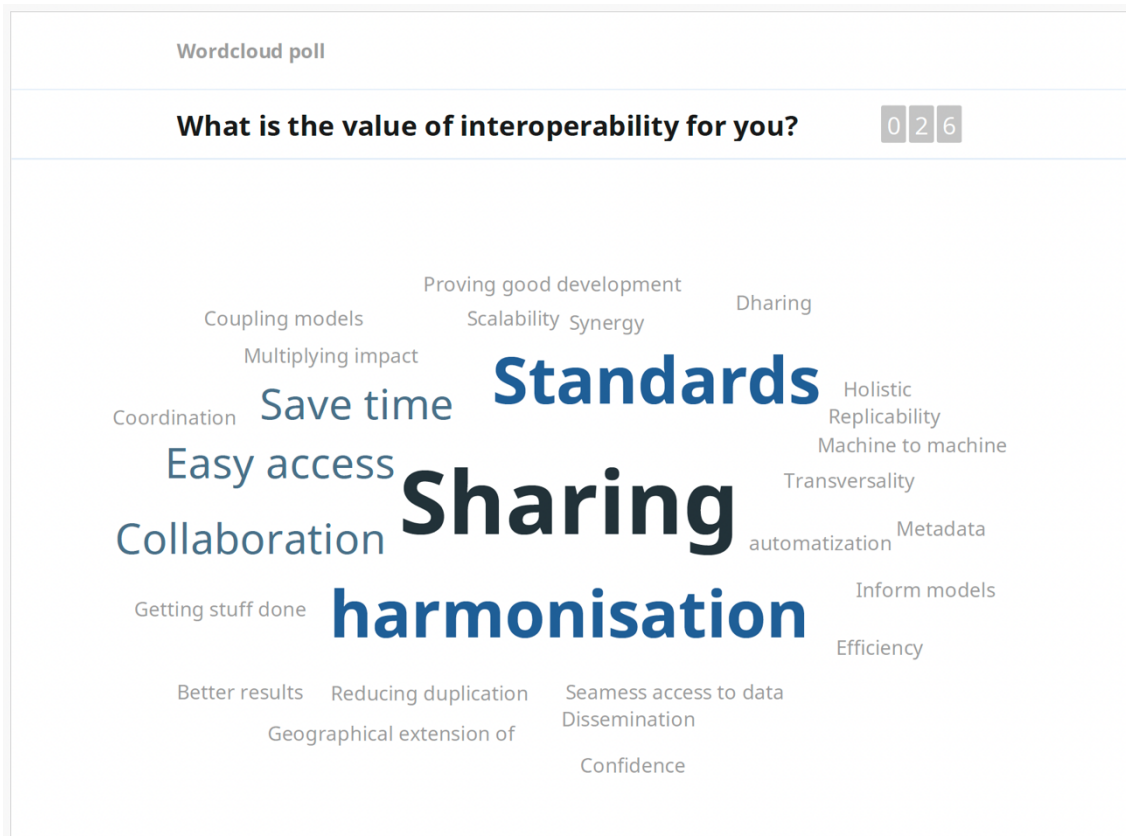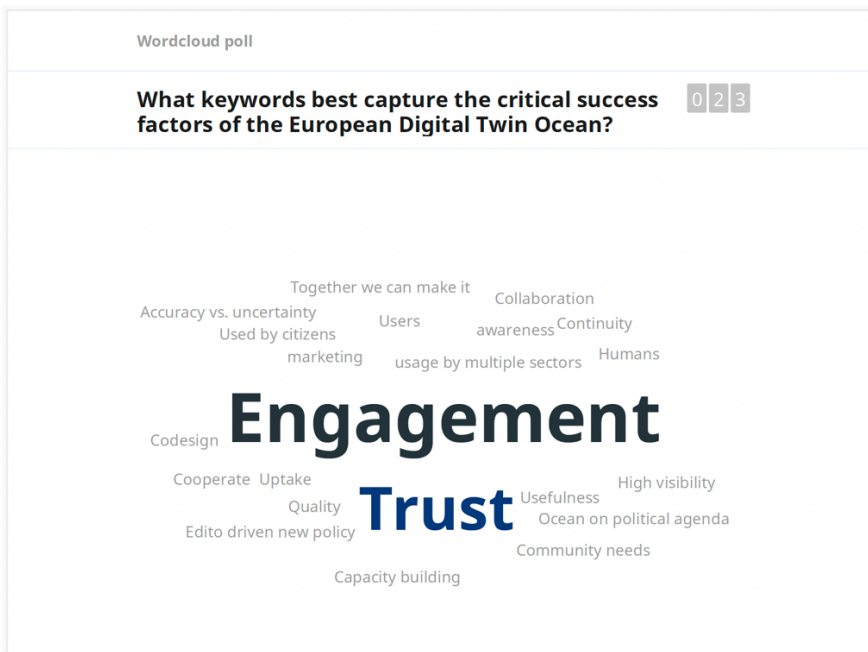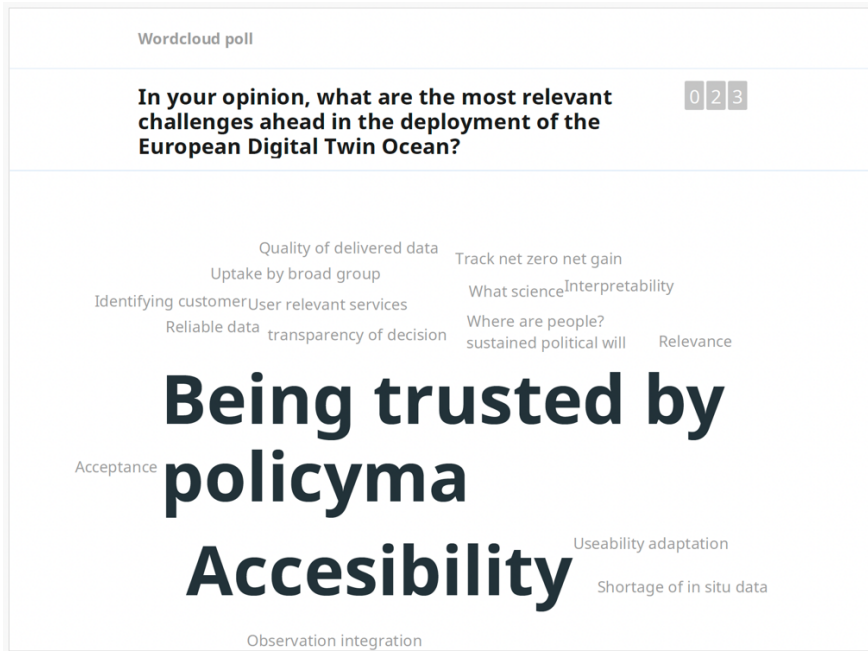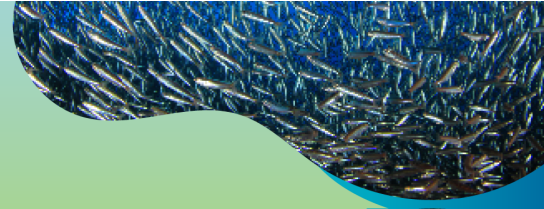
### 6.2.4.  Breakout Session 3: results from polls

The audience was asked to respond to several polls throughout Breakout Session 1. The results are available in the images below.

**\*\*\* End of Report \*\*\***

## To all Participants & Contributors, Thank You!