# A Digital Ocean Forum For Europe

# HIGHLIGHTS

## The European DTO is launched

At the One Ocean Summit hosted by the French Presidency of the Council of the EU in February 2022, more than 40 countries united to put the Ocean at the heart of the international political agenda.

To strengthen EU leadership in protecting the Ocean, European Commission President von der Leyen launched the European Digital Twin Ocean (DTO) to support the framework of the EU Mission Restore Our Ocean and Waters by 2030 and to enable the ambition of the European Green Deal.

At the One Ocean Summit, von der Leyen explained:

*"The ocean is still largely a great mystery for humankind. That is why Europe is building a digital twin of the ocean. We are connecting our assets – like the Copernicus satellites, marine infrastructure like icebreakers, buoys and underwater drones, and high-performance computing. We will gather the raw data and turn it into real-time knowledge and longer-term predictions. We are putting the power of the digital revolution at the service of our climate. (...) Thanks to the EU and its Member States, a digital twin should be operational by 2024. It will make ocean knowledge open-access, available to citizens, scientists and policymakers around the world. It will be a platform for global cooperation. It is about putting the capabilities in place to achieve the commitments we make at this Summit. Together, with the digital twin, we will turn the lights on in the ocean."*

The European Commission is investing €13 million to develop a core European DTO. This complements the €19 million project, *Iliad*, funded under the Green Deal Call for research proposals to pilot the DTO concept.

On 20 April 2022, more than 70 experts from 20 countries across Europe came together in Paris to develop a common vision for a European DTO and agreements on how to move forward together to meet this transformational challenge.

This event is part of the agenda of the French Presidency of the Council of the EU and was developed in collaboration with the European Commission's Directorate-General for Research (DG RTD) and Maritime Affairs and Fisheries (DG MARE), as well as the Directorate-General for Defense Industry and Space (DG DEFIS), Communications Networks, Content and Technology (DG CNECT), and the Commission's Joint Research Centre (JRC).



## Laying the Foundations of an Ocean Knowledge Service

Meeting the challenge of developing a digital twin of the Ocean will require more than connecting and improving what we already have and adding an attractive facade. It will require a complete disruption and paradigm shift in the way we think and work, co-designed by ocean experts and experts in state-of-the-art data science, accessibility and interoperability.

The Digital Ocean Forum brought together European and international experts selected on the basis of their proven expertise across multiple fields to agree on the fundamental principles and elements for the European DTO, building on European investments in ocean observations and ocean prediction to ensure that an 'ocean knowledge service' emerges from the DTO to meet user needs.

This new digital ocean community that convened in Paris covered the range of topics required to build a digital twin ocean, including autonomous in situ observing systems, new genomics and eDNA capabilities, ocean satellite missions and innovations, high-volume multi-dimensional variable arrays (datacubes) and data lakes, serverless data acess, data exchange standards and emerging standards, ingestion chains for future petabyte-scale analysis and forecasts, data usage monitoring, systems of interrelated computing devices with the ability to transfer data over a network without human interaction (Internet of Things), artificial intelligence, high-performance computing, global and coastal modeling (physics, biology, cryosphere), data exploration and visualization, workflow management, use cases and 'what if' scenario designs, natural system digital twin precursors, engineering and industrial twins, open science clouds, virtual laboratories, citizen science programmes, and ocean literacy.

# ⟫ Building a Common Vision and Framework

The interest in a Digital Twin Ocean is expanding and can be found on many national and international agendas. In the initial phase, there will be many smaller digital ocean systems developed for targeted uses or geographical areas, but they will all face the same challenges. Working together on these common foundational needs will help to align and integrate many twins into one and to optimize resources across the European partners for maximum delivery and impact.

To develop a common vision and framework for collaboration, experts addressed:

- the expectations, benefits, and impacts of a DTO,
- key success factors and the vision of a European DTO in 2030,
- European innovations leading DTO development,
- major components and coordination elements required,
- milestones for integrating domains of expertise into the DTO, and
- agreements on needs for standardized terminology.

From the consultation process initiated by the Digital Ocean Forum, a common vision for a European digital ocean has emerged and needs for collaborations have been identified.

## Forum Highlights: Fundamental Design and Collaboration Needs

A comprehensive report will be presented to the European Commission by the end of May that compiles and synthesizes the guidance received throughout this process. Experts at the Forum also highlighted key areas requiring continued communication and collaboration across European DTO partners:

**Work together to achieve key breakthroughs by 2024:** A shared vision, communication, collaboration across European DTO activities / Increased user engagement and co-design / Increased model reliability and uncertainty estimation / Increased ocean knowledge, improved uptake of models by different sectors, collaborations with ocean literacy / Augmented outputs for societal applications of Digital Twins to describe interactions between the natural system and human activities / A European DTO community established to facilitate alignment and interoperability with Destination Earth / The European DTO is recognized as a building block of the EU Ocean Mission knowledge system / The European DTO contributes to the UN Decade of Ocean Science for Sustainable Development.

**Establish the services to be provided by the European DTO**: Access to data; Data ingestion service / Access to computing capacity, virtual lab, and tools / On-demand modeling / processing service / Plug-ins and coupling to other twins' service / What-if scenario service / Visualization / User support and workflow management / Marketplace service / Collaborative tools.

**Co-design digital ocean knowledge systems with users (policy, science, industry, citizens).** Regular engagement with representatives of user groups is necessary to ensure that the ocean knowledge service generated by new digital ocean systems is fit-for-purpose. Early Career Ocean Professionals should be engaged as privileged partners in DTO co-design and development.

**Ensure alignment and enable integration of European DTO activities and outputs with other digital initiatives** including the international DTO programme (DITTO) of the UN Decade of Ocean Science for Sustainable Development and Destination Earth.

**Establish agreed standards and taxonomy**. Accessibility and quality of data requires using and/or developing accepted European or international standards. Standards should be considered on all levels, from taxonomy to vocabularies to formats to Application Programming Interfaces.

**Work with the Commission to ensure that European projects enter their data into European data systems for use by all** (EMODnet, Copernicus Marine Service, research infrastructures, etc.).

**Make best use of Artificial Intelligence to maximize the potential of a DTO.** Artificial intelligence techniques are revolutionizing ocean science and is a key success factor of a DTO. AI will deliver the necessary improved process understanding for a DTO, combining advanced machine-learning methods and ocean ecosystem models based on physics-guided machine learning and causal reasoning.

**Ensure that the DTO ocean knowledge system is based not only on scientific and technical aspects but also 'ethics by design', integrating concerns for social well-being and human rights.** The European DTO will follow the "EU Ethical Guidelines for Trustworthy AI".

**Recognize that DTO output and scenarios may need expert interpretation by scientists for use by the public**. The European DTO community should identify and limit risks of misuse and misinterpretation without imposing restrictions.

**Address observation and knowledge gaps that limit DTO development** through the development of a regularly updated science plan.

## "Align the ambitions of the European DTO

with the magnitude of Ocean challenges": this is one of the conclusions reached during the working session of the Forum. The ambition of the European Commission has been clearly heard by marine and digital experts, and the willingness to respond to it with a coordinated community effort immediately established. This is the only possible answer. This encourages to continue this community work, create the conditions to hold a 2nd edition of this Digital Ocean Forum within a reasonable time, establish the plans for our joint action, and develop our community to cover all the expertise necessary for a European DTO in an inclusive and open European network.