



Organisation [CNR]

Project Charter

EOSC Node | European Digital Twin Ocean (DTO)

1 PROJECT SUMMARY

The **European DTO Node** is the operational evolution of the **Blue-Cloud Marine Thematic Node**, established during the EOSC Federation Build-Up Phase. Through the **EOSC-Marine** project, the Node evolves into a fully operational thematic node of the EOSC Federation while becoming the **Open Science and research component of the European Digital Twin of the Ocean (EU DTO) ecosystem**, implemented through the European Digital Twin Ocean Platform (**EDITO**).

The European DTO Node establishes the strategic connection between the EOSC Federation and the European DTO, enabling scientific knowledge, FAIR data, analytical methods and digital services developed by the research community to flow towards operational Digital Twin services, while allowing operational marine data, services and computational capabilities from the DTO ecosystem to be exploited within collaborative Open Science environments. In this role, *the Node acts as the interoperable interface between research and operations, contributing to the long-term convergence of EOSC and the European Digital Twin of the Ocean.*

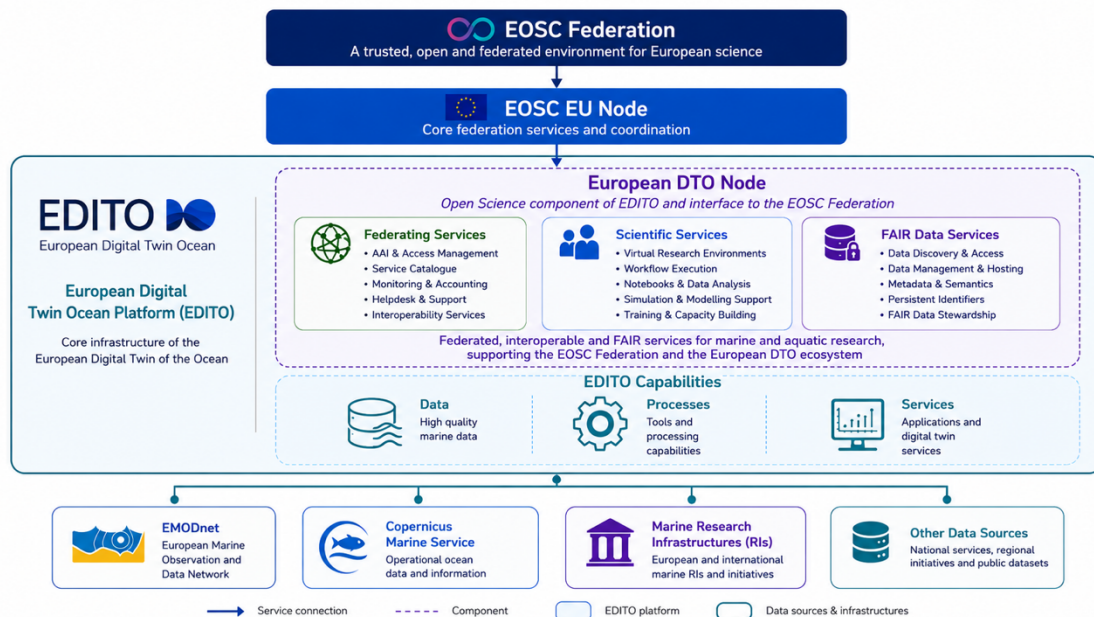
Within the EOSC Federation, the Node contributes a comprehensive portfolio of EOSC-compliant Federating Services and domain-specific scientific services supporting marine and aquatic research. These include Authentication and Authorisation Infrastructure (AAI), service catalogues, collaborative Virtual Research Environments, workflow execution services, data hosting and management, monitoring, accounting, helpdesk, interoperability services, semantic integration and FAIR data management capabilities. Building upon the D4Science infrastructure and the technological and scientific assets developed through Blue-Cloud, the Node provides a secure and scalable environment where researchers can discover, access, analyse, combine and share multidisciplinary marine data, models and analytical workflows following FAIR and Open Science principles.

As the Open Science component of EDITO, the European DTO Node provides a collaborative environment in which innovative scientific workflows, FAIR data products, artificial intelligence methods, numerical models, and digital services are co-designed, validated, and demonstrated before their transition to operational DTO services. The Node therefore functions as a research and innovation environment for the European DTO, ensuring continuous knowledge transfer among research communities, European Research Infrastructures, marine data infrastructures, operational services, and policy-driven initiatives supporting the EU Mission “Restore our Ocean and Waters”.

The Node federates multidisciplinary marine resources originating from European Research Infrastructures, EMODnet, Copernicus Marine and other Blue Data Infrastructures through interoperable discovery and access mechanisms, promoting metadata federation and cloud-native data access while preserving data ownership and stewardship. By acting as an interoperability layer between distributed marine infrastructures and the EOSC Federation, the Node facilitates cross-node scientific workflows and enables other EOSC Nodes to seamlessly discover and consume marine data and services.

Beyond service provision, the European DTO Node actively contributes to the evolution of the EOSC Federation through the operational validation of federating capabilities, the onboarding and enrolment of marine services, the adoption of common interoperability standards, governance activities, training programmes and the development of reusable practices for thematic node federation. *Its thematic scope encompasses oceans, European seas, coastal and inland waters, while maintaining interoperability with*

international marine research infrastructures and global ocean observing initiatives. Through these activities, the European DTO Node provides a sustainable gateway connecting the European marine research community, the EOSC Federation and the operational European Digital Twin of the Ocean.



2 VALUE PROPOSITION

2.1 Main Goal

The European DTO Node aims to establish a permanent research and innovation bridge between the EOSC Federation and the European Digital Twin of the Ocean (EU DTO). Its primary goal is to ensure that Open Science becomes an integral component of the European DTO ecosystem, enabling scientific knowledge, FAIR data, analytical workflows, models and digital services developed within the research community to continuously enrich operational Digital Twin capabilities, while making operational marine data, services and computing resources accessible through EOSC.

In fulfilling this role, the Node *contributes to the convergence of research and operations, fostering a continuous cycle of innovation in which scientific advances are rapidly translated into operational services and operational challenges stimulate new research activities*. This strategic positioning strengthens both the EOSC Federation and the European DTO, creating a sustainable ecosystem that accelerates scientific discovery, technological innovation and the operational evolution of the EDITO ecosystem.

2.2 Needs Addressed

The European DTO Node addresses several strategic challenges currently affecting the European research and digital infrastructure landscape.

- **Limited integration between Open Science environments and operational European digital infrastructures.** Although both ecosystems share common objectives, they have traditionally evolved independently. The Node establishes an interoperable connection that enables seamless collaboration among researchers, operational services, and digital twin technologies.
- **Domain-specific federated environments capable of supporting data-intensive marine and aquatic research.** Marine science increasingly relies on multidisciplinary observations, Earth observation products, numerical models and

artificial intelligence methods that require specialised collaborative environments operating close to distributed data sources and computing infrastructures.

- **Interoperability across European marine infrastructures.** The Node promotes common standards, interoperable metadata, federated discovery mechanisms and reusable scientific workflows that facilitate collaboration across Research Infrastructures, marine data infrastructures, thematic and national EOSC Nodes.
- **Operational validation of the EOSC Federation itself.** Through production services, cross-node scientific workflows and collaboration with other Candidate Nodes, it provides practical evidence for the implementation of federating capabilities, interoperability frameworks and onboarding procedures that can be reused across the Federation.

2.3 Key Benefits

The European DTO Node delivers value that extends beyond the marine research domain.

- **For the EOSC Federation,** it provides a reference implementation demonstrating how thematic research infrastructures, European Digital Twins and sectoral data spaces can be integrated through common federating capabilities and interoperable services. This experience contributes directly to the evolution of the Federation by validating technical solutions, governance models and collaborative practices in an operational environment.
- **For the European Digital Twin of the Ocean,** the Node establishes a sustainable research and innovation pipeline through which new scientific methods, FAIR data products and digital services can be collaboratively developed, validated and progressively adopted within operational DTO services.
- **For the broader European research ecosystem,** the Node promotes interdisciplinary collaboration, reduces fragmentation between infrastructures, facilitates the reuse of scientific resources and enables cross-domain research that would be difficult to achieve within isolated thematic environments.

2.4 Who Benefits

The primary beneficiary is the EOSC Federation, which gains an operational thematic node demonstrating how Open Science, Digital Twins and sectoral data spaces can be integrated through interoperable federating capabilities and reusable governance practices.

Marine and environmental researchers, universities and research institutes benefit from collaborative environments that enable seamless access to distributed data, analytical workflows and computational resources supporting reproducible and multidisciplinary science.

European Research Infrastructures, marine data infrastructures, e-infrastructures and other EOSC Nodes benefit from interoperable mechanisms for publishing, discovering and exchanging data, services and workflows, fostering collaboration across scientific domains and strengthening the overall Federation.

European institutions, public authorities and policymakers benefit from improved access to trusted scientific evidence supporting the implementation of the EU Mission “Restore our Ocean and Waters”, environmental legislation and climate policies.

Finally, industry, SMEs and international initiatives benefit from open access to interoperable scientific services, collaborative innovation environments and reusable digital solutions that facilitate technology transfer, innovation and international cooperation.

3 EUROPEAN DTO NODE ARCHITECTURE

3.1 Overview

The European DTO Node is the Open Science component of the European Digital Twin of the Ocean (EDITO) and the thematic marine node of the EOSC Federation. Its architecture has been designed according to the principles of the **EOSC Federation Handbook v2.0**, combining EOSC Federating Services with a rich portfolio of scientific resources that support collaborative, data-intensive marine research.

The Node does not centralise marine data or scientific services. Instead, it federates distributed resources provided by Research Infrastructures, EDITO (EMODnet, Copernicus Marine and other Blue Data Infrastructures), making them discoverable, accessible and reusable through common standards and interoperable services. Researchers access these distributed resources through a single collaborative environment where data, computing, analytical tools and scientific workflows are seamlessly integrated.

From a user's perspective, the European DTO Node provides a complete digital research environment in which scientists can discover data, execute analyses, develop models, publish results and collaborate with other research communities, while remaining fully connected to both the EOSC Federation and the operational European Digital Twin of the Ocean.

3.2 Federating Services

To participate in the EOSC Federation, the European DTO Node implements the Federating Services defined by the EOSC Federation Handbook. These services ensure secure operation, interoperability and trusted collaboration with the EOSC EU Node and other thematic and national EOSC Nodes.

The Node provides:

- **Federated Authentication and Authorisation (AAI)** enabling users to access services through a common identity;
- **Integration with EOSC Catalogues**, publishing research resources, services and digital objects for discovery across the Federation;
- **Monitoring and Accounting**, providing operational monitoring and usage reporting;
- **Helpdesk and User Support**, assisting users and service providers during onboarding and operation;
- **Security and Service Management**, ensuring trusted operation according to EOSC Federation policies.

These services make the European DTO Node a fully interoperable participant in the EOSC Federation while offering users a seamless experience across collaborating Nodes.

3.3 Node Scientific Resources and Services

The scientific value of the European DTO Node is delivered through a comprehensive portfolio of Node Resources that combine collaborative environments, scientific applications and FAIR data services.

- **Collaborative Research Environments.** Researchers are provided with Virtual Research Environments (VREs) and Virtual Laboratories (VLabs) where multidisciplinary teams can collaborate, share data, execute analyses and publish research outputs.

- **Scientific Computing Services.** The Node offers a rich set of cloud-based analytical environments, including:
 - Jupyter Notebooks;
 - RStudio;
 - Galaxy workflows;
 - RShiny applications;
 - Containerised execution environments;
 - Interactive terminals and workflow orchestration services.

These services allow researchers to execute reproducible scientific analyses without installing local software and close to the distributed data sources.
- **Data Discovery and FAIR Data Services.** The European DTO Node enables researchers to discover and access distributed marine resources through interoperable catalogues and FAIR data services, including:
 - STAC (SpatioTemporal Asset Catalog) catalogues for cloud-native metadata federation;
 - GeoNetwork metadata catalogues;
 - GeoServer services for interoperable geospatial data publication;
 - OGC-compliant APIs and web services;
 - Semantic interoperability services;
 - Persistent Identifiers (PIDs) and FAIR Digital Object publication.

A key innovation of the Node is the adoption of **STAC-based metadata federation**, allowing large marine datasets to remain within their original repositories while exposing interoperable metadata across the EOSC Federation. This cloud-native approach avoids unnecessary data duplication, preserves data ownership and enables scalable discovery and machine-to-machine access to distributed scientific resources.
- **Data Management and Publishing.** The Node provides collaborative storage, shared workspaces, data lakes, data publication services and FAIR Digital Object management, enabling research teams to organise, preserve and publish scientific assets throughout their lifecycle.
- **Scientific Applications.** The European DTO Node hosts a growing portfolio of scientific applications supporting marine and aquatic research, including:
 - Digital Twin experimentation environments;
 - Essential Ocean Variable (EOV) workbenches;
 - Ocean and climate modelling workflows;
 - Biodiversity and ecosystem analysis services;
 - Fisheries and marine observation applications;
 - Artificial Intelligence and Machine Learning services;
 - Interactive dashboards and visual analytics;
 - Reusable scientific workflows and research software.

These applications constitute the research and innovation environment through which new scientific capabilities are developed and validated before their potential transition into operational services of the European Digital Twin of the Ocean.

3.4 Interoperability within the European Digital Ecosystem

The distinguishing characteristic of the European DTO Node is its ability to connect multiple European digital ecosystems through interoperable services.

The Node interoperates with:

- the EOSC EU Node and other thematic and national EOSC Nodes;
- the EDITO platform and the operational European Digital Twin of the Ocean;

- EMODnet and Copernicus Marine (via EDITO);
- European and international Research Infrastructures;
- Blue Data Infrastructures and other sectoral data spaces (via EDITO).

Through common metadata standards, federated catalogues, persistent identifiers, APIs and cloud-native discovery mechanisms, the European DTO Node enables scientific resources to be shared across organisational and disciplinary boundaries without requiring centralisation of data or services.

This interoperability layer represents one of the main strategic contributions of the European DTO Node to the EOSC Federation. Beyond providing services for marine science, it demonstrates how Open Science infrastructures, Research Infrastructures, Digital Twins and European data spaces can operate as a coherent and interoperable ecosystem supporting collaborative research and innovation.

4 USE CASE(S)

The European DTO Node delivers a set of operational use cases demonstrating how the EOSC Federation enables collaborative marine research through federated services, interoperable infrastructures and cross-node scientific workflows. These use cases describe the operational capabilities available to researchers, research infrastructures, and other EOSC Nodes, illustrating the added value of the Federation in terms of interoperability, service sharing, and collaborative Open Science.

Use Case ID	Short Description
UC1 – Smart Federation between EOSC and EDITO	Researchers seamlessly access interoperable research environments and services across the EOSC Federation and the European Digital Twin of the Ocean (EDITO).
UC2 – FAIR Federated Marine Data Services	Researchers and applications discover, access and exploit distributed marine data through interoperable catalogues, STAC federation and FAIR data services.
UC3 – Marine Open Science and Digital Twin Applications	Researchers develop, execute and share advanced marine analytical workflows, models and Digital Twin applications within collaborative Virtual Research Environments.
UC4 – Cross-Node Scientific Workflows	Scientific workflows combine services, data and computational resources provided by multiple EOSC Nodes to enable multidisciplinary research across domains.
UC5 – Reusable Scientific Services across the EOSC Federations	The European DTO Node exchanges services, workflows and research resources with other EOSC Nodes, demonstrating reusable federating capabilities and scalable service provision.

4.1 UC1 – Smart Federation between EOSC and EDITO

4.1.1 Use Case Description

Researchers seamlessly access and use interoperable research environments across the EOSC Federation and the European Digital Twin of the Ocean (EDITO). Through harmonised authentication, interoperable workflows and shared computational environments, users can develop, execute and share scientific analyses regardless of whether resources are hosted within EOSC or EDITO.

4.1.2 Value Proposition

This use case demonstrates how the EOSC Federation can interoperate with a European Digital Twin, creating a continuous research-to-operations ecosystem. It establishes the European DTO Node as the Open Science gateway to EDITO while validating interoperable federating capabilities between two major European research infrastructures.

4.1.3 In Scope

- Interoperability between the European DTO Node and EDITO.
- Federated Authentication and Authorisation (AAI).
- Shared Virtual Research Environments and workflow execution.
- Harmonised access to scientific services and computational resources.
- Integration with EOSC Federating Services and EOSC EU Node architecture.

4.1.4 Out of Scope

- Replacement of EDITO operational services.
- Duplication of EDITO infrastructure.
- Development of operational Digital Twin services outside the EDITO programme.
- Integration with external infrastructures not participating in agreed interoperability activities.

4.2 UC2 – FAIR Federated Marine Data Services

4.2.1 Use Case Description

Researchers and applications discover, access and analyse distributed marine datasets originating from Research Infrastructures, EMODnet, Copernicus Marine and other Blue Data Infrastructures through interoperable metadata catalogues and cloud-native data access mechanisms.

4.2.2 Value Proposition

This use case demonstrates the EOSC Federation's ability to federate distributed scientific data without centralising large datasets. It promotes FAIR principles, scalable machine-to-machine interoperability and efficient reuse of marine research resources across Europe.

4.2.3 In Scope

- STAC-based metadata federation.
- FAIR data publication and discovery.
- Integration with EMODnet, Copernicus Marine and Research Infrastructures.
- Data Lakes and analysis-ready data services.
- GeoNetwork, GeoServer and interoperable OGC APIs.
- Semantic interoperability and Persistent Identifiers.

4.2.4 Out of Scope

- Centralised replication of marine repositories.
- Replacement of existing marine data infrastructures.
- Long-term curation of third-party repositories.
- Management of data outside agreed interoperability frameworks.

4.3 UC3 – Marine Open Science and Digital Twin Applications

4.3.1 Use Case Description

Researchers exploit collaborative Virtual Research Environments to develop, execute, and share advanced scientific workflows that address key marine challenges. These environments provide integrated access to FAIR data, computational resources, and

scientific applications that support modelling, artificial intelligence, and Digital Twin experimentation.

Scientific demonstrators developed within EOSC-Marine, including applications addressing ocean physics, biodiversity, fisheries, eutrophication, acidification and carbon dynamics, validate the operational capabilities of the European DTO Node.

4.3.2 Value Proposition

This use case demonstrates how EOSC enables reproducible, collaborative and data-intensive marine science while accelerating the development of innovative Digital Twin applications that can subsequently mature into operational services.

4.3.3 In Scope

- Virtual Research Environments and Virtual Laboratories.
- Jupyter Notebook, RStudio and Galaxy environments.
- AI and Machine Learning services.
- Workflow orchestration and scientific applications.
- Interactive visualisation and collaborative research.
- Publication of reusable workflows and research products.

4.3.4 Out of Scope

- Generic cloud computing unrelated to marine research.
- Dedicated HPC services provided by external infrastructures.
- Commercial software development.
- Operational management of Digital Twin applications after their transition to EDITO.

4.4 UC4 – Cross-Node Scientific Workflows

4.4.1 Use Case Description

Researchers execute multidisciplinary scientific workflows by combining services, datasets and computational resources provided by multiple EOSC Nodes. These workflows integrate complementary capabilities from thematic and national Nodes to address complex scientific challenges that cannot be solved within a single research domain.

4.4.2 Value Proposition

This use case demonstrates one of the core benefits of the EOSC Federation: enabling interoperable scientific workflows across organisational, disciplinary and geographical boundaries. It validates federating capabilities through real cross-node collaboration while promoting reuse of services and research resources.

4.4.3 In Scope

- Cross-node workflow execution.
- Integration with thematic and national EOSC Nodes.
- Federated access to distributed services.
- Exchange of workflows and research resources.
- Demonstration of interoperable scientific applications.

4.4.4 Out of Scope

- Tight integration with every EOSC Node, irrespective of scientific relevance.
- Replacement of services operated by collaborating Nodes.
- Duplication of federating capabilities already provided by the EOSC EU Node.
- Domain-specific developments outside agreed collaboration activities.

4.5 UC5 – Reusable Scientific Services across the EOSC Federations

4.5.1 Use Case Description

The European DTO Node publishes reusable scientific services, workflows, notebooks, models and research resources that can be discovered and reused by other EOSC Nodes. Likewise, it consumes federated services provided by other Nodes, contributing to a scalable ecosystem based on shared capabilities rather than duplicated implementations.

4.5.2 Value Proposition

This use case demonstrates how the EOSC Federation scales through service sharing and reuse. It promotes interoperability, reduces duplication of effort and contributes operational experience for the evolution of EOSC Federating Capabilities.

4.5.3 In Scope

- Publication of reusable workflows and scientific services.
- Sharing of notebooks, models, containers and applications.
- Exchange of research resources with other EOSC Nodes.
- Validation of Federating Capabilities through operational services.
- Support for onboarding interoperable scientific services.

4.5.4 Out of Scope

- Mandatory adoption of European DTO Node services by other Nodes.
- Replacement of local implementations where equivalent services already exist.
- Provision of unrestricted hosting for external services outside agreed onboarding procedures.
- Management of federation-wide governance activities.

5 EXTERNAL DEPENDENCIES & KEY RISKS

The successful operation of the European DTO Node depends on a number of external technical, organisational and governance factors. Most of these dependencies arise from its role as an interoperable component of both the EOSC Federation and the European Digital Twin of the Ocean (EDITO). The Node actively contributes to mitigating these risks through close collaboration with the EOSC Association, the EOSC EU Node, EDITO, European Research Infrastructures and other EOSC Nodes.

External Dependency / Risk	Actions / Mitigation Measures	Target Timeframe
Evolution of the EOSC Federation Handbook, Interoperability Framework and Federating Capabilities. Changes in federation specifications may require adaptations of Node services and interfaces.	Continuous participation in EOSC technical and governance activities; progressive alignment of Federating Services with evolving EOSC specifications; adoption of open standards and modular service architecture.	Throughout the project and Node operation
Availability of EOSC EU Node Federating Services (AAI, Catalogues, Monitoring, Helpdesk and related federation services). Delays or changes may affect interoperability testing and operational integration.	Close technical collaboration with the EOSC EU Node; phased integration strategy; temporary fallback mechanisms where technically feasible.	Throughout the project
Interoperability with EDITO and underlying marine infrastructures (EMODnet, Copernicus Marine). Successful operation depends on stable interfaces, metadata harmonisation and coordinated evolution of the connected platforms.	Joint technical roadmap with EDITO partners; adoption of interoperable APIs and metadata standards; coordinated release planning and continuous interoperability testing.	Throughout the project

Availability and quality of services provided by European Research Infrastructures and Blue Data Infrastructures.	Promote common FAIR practices; implement automated quality monitoring; establish service-level agreements and regular technical coordination with infrastructure operators.	Throughout the project
Adoption of interoperability standards (OGC APIs, STAC, FAIR Digital Objects, Persistent Identifiers, semantic vocabularies). Delayed adoption by external providers may reduce interoperability.	Promote standardisation through onboarding activities, technical guidance and community engagement; maintain compatibility with widely adopted international standards.	Continuous
Cross-node interoperability with thematic and national EOSC Nodes. Differences in maturity, technical implementations or priorities may delay the deployment of distributed scientific workflows.	Incremental interoperability pilots; early engagement with collaborating Nodes; validation through federation demonstrators and reusable integration patterns.	M12–M36
Operational sustainability beyond the EOSC-Marine project. Long-term operation depends on sustained governance, operational resources and alignment with the EDITO roadmap and EOSC governance.	Development of the Governance and Sustainability Plan; integration within the EDITO operational ecosystem; engagement with funding bodies and long-term infrastructure operators.	M18–M36
Cybersecurity and operational security risks. As a federated operational node, the platform must ensure secure access, protection of research assets and resilience against cyber threats.	Adoption of EOSC security policies; regular vulnerability assessments; security monitoring; incident response procedures; compliance with organisational security frameworks.	Continuous
Data protection and legal compliance. Management of user identities, usage information and research assets must comply with GDPR and applicable European regulations.	Privacy-by-design approach; GDPR compliance; Data Management Plan; regular review of legal and data protection procedures.	Continuous
Resource availability and technical capacity. Growth in the number of users, services and federated datasets may require additional computing, storage and operational support resources.	Continuous monitoring of infrastructure utilisation; scalable cloud-based architecture; capacity planning; progressive optimisation of computing and storage resources.	Continuous
Community adoption and onboarding of new services. The value of the Node depends on the active participation of researchers, Research Infrastructures and third-party service providers.	Community engagement, training, open calls, onboarding support and close collaboration with marine research communities and EOSC stakeholders.	M6–M36

6 CONTRIBUTIONS

6.1 Role in the EOSC Federation

The European DTO Node operates as the thematic EOSC Node for marine and aquatic research and as the Open Science component of the European Digital Twin of the Ocean (EDITO). It contributes interoperable Federating Services, FAIR marine data resources, scientific services and operational expertise supporting the implementation, validation and long-term evolution of the EOSC Federation.

6.2 Main Contributions

The European DTO Node contributes to the EOSC Federation by:

- establishing a smart federation between the EOSC Federation and the European Digital Twin of the Ocean (EDITO);
- providing EOSC-compliant Federating Services and interoperable scientific services for marine and aquatic research;
- delivering FAIR federated marine data services through cloud-native data access and interoperable metadata federation;
- enabling cross-node scientific workflows and reusable scientific applications across the EOSC Federation;
- validating EOSC Federating Capabilities through operational scientific services and multidisciplinary federation demonstrators.

6.3 Deliverables (Operational Contributions)

The following operational contributions establish the traceability between the strategic use cases of the European DTO Node and the corresponding EOSC-Marine deliverables.

Use Case	Operational Contribution	Supporting EOSC-Marine Deliverables	Lead Partner(s)
UC1 – Smart Federation between EOSC and EDITO	Smart federation between the D4Science Virtual Research Environment and the EDITO Datalab, enabling seamless user experience, interoperable workflows and harmonised access across the two ecosystems.	D2.1 – Interoperability Framework and Smart Federation Model; D2.2 – Strategic Implementation Blueprint; D3.3 – EOSC Node Integrated Workflow Framework and Reference Implementation	Mercator Ocean (MOI), CNR
UC2 – FAIR Federated Marine Data Services	FAIR marine data services providing federated discovery, cloud-native access and interoperable publication of distributed marine resources through STAC federation, semantic interoperability and Data Lakes.	D4.1 – Architecture for making the EDITO STAC catalogue available in EOSC; D4.2 – Semantic solutions and enhancements made to support RI data access; D4.3 – Publication of RI data access service and data aggregation; D4.4 – Data Access Design and Architecture; D4.5 – Performance Analysis results of the UDAL brokers	VLIZ
UC3 – Marine Open Science and Digital Twin Applications	Operational thematic services, scientific workflows and Digital Twin applications supporting marine and aquatic research and validating EOSC Exchange Capabilities through scientific demonstrators.	D5.1 – Thematic services – User manual and documentation (beta); D5.2 – Operational Thematic services and documentation	IFREMER
UC4 – Cross-Node Scientific Workflows	Federated scientific workflows combining services, datasets and computational resources from the European DTO Node and other EOSC Nodes, validating interoperability and distributed workflow execution across the Federation.	D2.1 – Interoperability Framework and Smart Federation Model; D3.3 – EOSC Node Integrated Workflow Framework and Reference Implementation; D4.3 – Publication of RI data access service and data aggregation; D5.2 – Operational Thematic services and documentation	Mercator Ocean (MOI), CNR, VLIZ, IFREMER
UC5 – Reusable	Publication and reuse of Federating Services, scientific	D3.1 – EOSC Node Core and Generic Capabilities: First	CNR, Seascope

Scientific Services across the EOSC Federations	workflows, notebooks, models and interoperable services enabling scalable service sharing across the EOSC Federation.	Release; D3.5 – EOSC Node Core and Generic Capabilities: 2nd Release; D5.2 – Operational Thematic services and documentation; D6.2 – Mapping of existing EOSC assets of relevance for the marine thematic node and recommendations towards federation; D6.3 – Governance & Sustainability Plan	Belgium (SSBE), IFREMER
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7 TIMING AND MILESTONES

The implementation of the European DTO Node follows the EOSC-Marine roadmap, progressively evolving the current marine thematic node into a fully operational EOSC Node integrated with the European Digital Twin of the Ocean (EDITO). The following milestones represent the principal operational achievements of the Node.

ID	Milestone Description	Target Delivery Date
MS1	EOSC-Marine project initiated and European DTO Node implementation launched. Project governance established and alignment with the EOSC Federation and EDITO roadmaps initiated.	September 2026 (M1)
MS2	Initial EOSC Federating Services operational, including alignment of the European DTO Node with the EOSC Federation architecture and first integration of Federating Capabilities.	December 2026 (M4)
MS3	Smart federation between the D4Science Virtual Research Environment and the EDITO Datalab operational, including interoperable workflows and STAC-based metadata federation.	June 2027 (M10)
MS4	FAIR federated marine data services operational, providing interoperable access to distributed marine resources from Research Infrastructures, EMODnet and Copernicus Marine through EOSC-compliant services.	Q2 2028 (M20–M24)
MS5	Marine thematic services and first EOSC Federation demonstrators operational, validating EOSC Federating Capabilities through Digital Twin applications and multidisciplinary scientific workflows.	Q1 2028 (M18–M20)
MS6	Cross-node scientific workflows demonstrated with thematic and national EOSC Nodes, validating interoperability, service exchange and distributed workflow execution across the EOSC Federation.	2028 (M24–M30)
MS7	European DTO Node fully operational as the Open Science component of the European Digital Twin of the Ocean, supported by an agreed governance framework, sustainability plan and operational onboarding of new services.	August 2029 (M36)

8 CONTACT & SUBMISSION

The following contacts represent the European DTO Node for scientific, operational, technical and organisational matters within the EOSC Federation.

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