D 2.4 Innovation Management and Exploitation Progress Report

Status: Approved by the EC
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Abstract

Key Words	Innovation Management, Exploitation, IP Management

The document provides an update of the innovation processes, guidelines and instruments along with the exploitation activities and plans as defined in D2.2. interTwin is a project to co-design and implement the prototype of an interdisciplinary Digital Twin Engine (DTE), that enables the implementation of application-specific Digital Twins (DTs).

In this deliverable, the progress of innovation management activities are presented.

- For the Understanding the Market, Technological and Political Context the market analysis is expanded to provide a broader understanding of the upstream, horizontal and downstream markets and the relevance to interTwin, main stakeholders are listed including ongoing collaboration opportunities and actions, the progress of the External Expert Advisory Board meetings organization and feedback is provided. Also an annex provides the list of news tracked under technology watch
- For the results collection and IP management, the detail of the 42 results collected at M22 is provided, including their ownership, IPR, access license. Key Exploitable Results information is expanded indicating the subcomponents included for each of them.
- For the exploitation progress, the summary of the business modelling workshops organized is provided -including the early outcomes of the initial Business Model Analysis that helps to understand the exploitation strategy of the project and the work performed for involving SMEs and industrial parties. Also the progress of all the exploitation activities for each of the Key Exploitable Result is provided - including those for Further Research, the creation of new Products and Services (or the improvement of already existing ones) and standardization efforts.

Follow-up progress will be presented in subsequent deliverable D2.6 (M36) focusing on the sustainability plan and the exploitation success stories.

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D2.4 Innovation Management and Exploitation Progress Report

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When the terminology/acronyms are available via link below, please remove this table.

Terminology / Acronyms

Term/Acronym	Definition
DT	Digital Twin
DTE	Digital Twin Engine
KER	Key Exploitable Result
DoA	Description of Action
GA	Grant Agreement
CA	Consortium Agreement
DestinE	Destination Earth
EEAB	External Expert Advisory Board
EOSC	European Open Science Cloud
ETP4HPC	European Technology Platform For High Performance Computing
EuroHPC	European High-Performance Computing Joint Undertaking
HPC	High-Performance Computing
HTC	High-Throughput Computing
IEG	Innovation and Exploitation Group
IMS	Innovation Management System
IP	Intellectual Property
IPR	Intellectual Property Rights
PEST Analysis	Political, Economic, Social and Technological Analysis
TRL	Technology Readiness Level

TCB	Technical Coordination Board
AMB	Activity Management Board
WfMSs	Workflow Management Systems

Terminology / Acronyms: **https://confluence.egi.eu/display/EGIG**

Table of Contents

Executive summary

The document provides an update of the innovation processes, guidelines and instruments along with the exploitation activities and plans as defined in D2.2. interTwin is a project to co-design and implement the prototype of an interdisciplinary Digital Twin Engine (DTE), that enables the implementation of application-specific Digital Twins (DTs).

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1 Introduction

interTwin co-designs and implements the prototype of an interdisciplinary Digital Twin Engine (DTE) - an open-source platform based on open standards, that enables the development and implementation of application-specific Digital Twins (DTs). Its functional specifications, development and implementation are based on a co-designed interoperability framework and conceptual model of a DT for research - the DTE blueprint architecture. The ambition of interTwin is to create consensus on a common approach to the implementation of DTs that is applicable across a wide spectrum of scientific disciplines that will facilitate developments and interoperability across different DTs.

1.1 Scope and Purpose

As part of Work Package WP2 (Innovation Management and Communications), Task T2.1 (led by EGI.eu) deals with Innovation Management and Exploitation. This deliverable (D2.4) presents the progress towards the plan for these activities as defined in D2.2. The document builds on the innovation processes, guidelines and instruments along with the exploitation activities and plans[1]. This report also includes an initial business model analysis and sustainability plan.

The activities outlined in this report address the progress in the implementation of the innovation management system of the project and towards the different main activities of the work package. This includes:

- An extended description of the market analysis, value chain, stakeholder analysis, External Expert Advisory Board (EEAB) feedback and technology watch - part of the political, technological and market context – which ensures the project remains relevant from a market perspective and enables leveraging the market-pull opportunities arising from the feedback collected from external sources
- The project results identified at M22 with all the necessary information related to Ownership, IP Rights, Access Conditions and an update on the development progress of the 6 Key Exploitable Results of the Project. It enables leveraging the technology-push opportunities arising from the technical work within the project.
- An update of the exploitation activities performed or planned at M22 that ensures the results are further developed, re-used and adopted beyond the project context or after the end of the project.

With the help of T2.2 (Dissemination, Communications and Engagement), and completing the stakeholder engagement of D2.3, main project stakeholders are identified and engagement actions assessed, to ensure maximum accessibility and reuse of the results and hence to maximize the emergence of project outcomes.

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[1] https://zenodo.org/records/10721988

This plan is designed to be a living document and does not offer final plans/solutions for all the activities and components developed in the project. Information is regularly updated in the Innovation Management register, part of the interTwin confluence repository. The development is co-advised by the Innovation and Exploitation Group and EEAB members. As the project is heading to the final year, parts of this plan will be updated or amended, depending on the main achievements at the end of the project. Any needed updates or corrections will be included in the final innovation management report deliverable in M36 (D2.6).

1.2 Structure of the document

This document contains the innovation management and exploitation progress for the project. The introduction provides the basics of the project including the context and framework, and some important definitions. Section 2.1 includes the update at M22 of the interTwin Market, Technological and Political Context. Section 2.2 describes the progress in the results collection and IP Management. Section 2.3 provides the progress towards the exploitation activities and initial business model analysis. Finally, Section 3 exposes conclusions and the next steps.

1.3 Framework and Context

The work to be performed by the Innovation Management plan is described in Task 2.1 of WP2 of interTwin DoA. It entails the definition of an Innovation Management System that,

- *Implements and conducts an operational innovation management process that ensures all project results are systematically captured, assessed for exploitation readiness and validated along with an improvement cycle to strengthen them.*
- *Organises relevant meetings and hands-on workshops (e.g. on business models) that will support the complete innovation management lifecycle.*
- *Coordinates dissemination and the implementation of the exploitation plan, monitoring dissemination effectiveness and potentially changing market landscapes, responding to feedback and the potential for new business opportunities.*

The main task outputs are:

- D2.2. Innovation Management and Exploitation Plan: M6
- D2.4 Innovation Management and Exploitation Report and Updated Plan.
- D2.6 Final report on Innovation Management, Exploitation and Sustainability (M36)

This deliverable is built from D2.2, and describes the progress in the 3 main activities of the plan up to M24. Some parts of D2.4 are directly taken or derived from the initial deliverable to ensure the correct readability of the document. Other sections such as the

plan and the procedures are omitted in this deliverable to focus on the added value aspects and the project progress.

This deliverable complements the other deliverables in WP2 referring to the dissemination task

- D2.1. Communication, Dissemination and Engagement Plan
- D2.3. Communication, Dissemination and Engagement Activity Report and Updated Plan
- D2.4. Final report on Communication, Dissemination and Engagement

In the above, the main target groups and target audiences need to be in line with the main stakeholders. In the middle of the project period, dissemination activities will aim to promote the uptake of project results and key exploitable results. At the end of the project, successful exploitation will be disseminated as success stories.

This deliverable also follows the procedures described in D1.1 / D1.3 - Quality and Risk Management Plan, and contributes to the development of the Data management plan D1.2 / D1.4

Here, a high-level description of each of the components produced by the project is provided. Further information on these can be found in the initial versions of the deliverables written under the technical work packages. Further detail can be found in the following deliverables:

Blueprint and Interoperability Deliverables:

- D3.4 Blueprint architecture, functional specifications, and requirements analysis second version
- D3.2 DTE First software release
- D3.3 Interoperability protocols for data, metadata and workflow semantics across disciplines and research infrastructures report

Components design:

- D5.1 First Architecture design and Implementation Plan
- D6.1 Report on requirements and core modules definition
- D7.1 Report on requirements and thematic modules definition for the environment domain
- D7.2 Report on requirements and thematic modules definition for the physics domain first version
- D4.2 First Architecture design of the DTs capabilities for High Energy Physics, Radio astronomy and Gravitational-wave Astrophysics
- D4.1 First Architecture design of the DTs capabilities for climate change and impact decision support tools.

KPIs and outcome and impact metrics needed to track the success of the project will be added in the Progress Report M24.

It is noteworthy to highlight the work related to the interTwin project is bound to the following legal documents:

- Grant Agreement Nr. 1010583836 between the European Commission and the Coordinator (EGI)
- Consortium Agreement between all project partners

In these documents, specific articles and clauses regulate exploitation, results, ownership and joint ownership, access, and open science among others. Some of those have been included in the definitions (Section 1.4).

1.4 Definitions

The keywords "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in **RFC 2119**[2].

Table 1 - Definitions

Definition	Description	Reference
Exploit(ation)	*The use of results in further research and innovation activities other than those covered by the action concerned, including among other things, commercial exploitation such as developing, creating, manufacturing, and marketing a product or process, creating, and providing a service, or in standardisation activities*	interTwin Grant Agreement
Innovation	*A new or changed entity, realising, or redistributing value. An entity is anything perceivable or conceivable, such as a product, service, process, model, method, or a combination of thereof. They can be material, immaterial or imagined.*	**ISO56000**[3]
	The successful exploitation of new creations (inventions) which can be used to produce tangible benefit, satisfying needs and wants.	**Innovation Radar**[4]

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[2] https://datatracker.ietf.org/doc/html/rfc2119

[3] https://www.iso.org/standard/68221.html

[4] https://www.innoradar.eu/methodology

Innovation management system	*Set of interrelated or interacting elements of an Organization / Project to establish strategies, policies and objectives and Processes to achieve those objectives with regard to innovation*	**ISO56000**
Innovation Policy	*Intentions and direction of an Organisation as formally expressed by its top management with regard to innovation*	**ISO56000**
Innovation Strategy	*Plan to achieve objectives with regard to innovation*	**ISO56000**
Process	*Set of interrelated or interacting activities that use inputs to deliver an intended result*	**ISO56000**
Background	*Any data, know-how or information — whatever its form or nature (tangible or intangible), including any rights such as intellectual property rights — that is:* • *(a) held by the beneficiaries before they acceded to the Agreement and* • *(b) needed to implement the action or exploit the results*	interTwin Grant Agreement
Results	*Any tangible or intangible effect of the action, such as data, know-how or information, whatever its form or nature, whether or not it can be protected, as well as any rights attached to it, including intellectual property rights.*	interTwin Grant Agreement
	What is generated during the project implementation. This may include, for example, ***know-how, innovative solutions, algorithms, proof of feasibility, new business models, policy recommendations, guidelines, prototypes, demonstrators, databases and datasets, trained researchers, new infrastructures, networks, etc.*** *Most project results (inventions, scientific works, etc) are 'Intellectual Property', which may, if appropriate, be protected by formal 'Intellectual Property Rights*	**European Commission Horizon Europe Guidelines**[5]

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[5] https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/programme-guide_horizon_en.pdf

Key Exploitable Result	A Key Exploitable Result (KER) is an identified main interesting result (as defined above) which has been selected and prioritised due to its high potential to be "exploited" – meaning to make use and derive benefits- downstream the value chain of a product, process or solution, or act as an important input to policy, further research, or education.	**European Commission Horizon Europe Guidelines**
KER Champion	*The KER Champions are responsible for ensuring engagement with all relevant WPs and supporting the provision of information and analysis for each of the assigned KERs. Altogether they form the Innovation and Exploitation Group (IEG)*	Own Definition (DoA)
Innovation and Exploitation Group (IEG)	*Supports innovation management system processes over the project duration. Drives implementation of the project's knowledge and protection strategy. Collects and maintains the information related to project KERs as well as updating and monitoring dissemination and exploitation plan in line with the innovation management task (T2.1). This includes The management of IPR, access rights of project's background and foreground The maintenance of information related to dissemination and exploitation activities. Gives direction and facilitates discussion for capturing opportunities and developing initial technical concept candidates.*	Own Definition (DoA)
Innovation Capacity	*Do the project results have the capacity to stimulate further innovations? Does it have the potential to be used in other areas (beyond the project objectives)*	**Innovation Radar**[6]
Innovation Potential	*How much benefit (innovation) can the project results potentially deliver*	**Innovation Radar**
Innovation Management	*(EC definition) Management of all the activities related to understanding needs with the objective of successfully identifying new ideas and managing them, in order to develop new*	**IP Helpdesk**

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[6] https://www.innoradar.eu/methodology

	products and services which satisfy these needs.)	
Intellectual Property (IP)	*Refers to creations/products of the mind, such as inventions, research & experimentation, or products of creativity. Like physical property, IP is an asset which can be traded (sold, bought, leased, used, or given away), and is protected by law.*	**IP Helpdesk Glossary**[7]
Intellectual Property Rights (IPR)	*Is the legal right granted to IP owners to protect their IP, enabling people to earn recognition or financial benefit from what they invent or create. Some common types of IPR are:* ● ***Copyright*** *(Software, written works, engineering drawings…) – it comes into existence automatically upon the creation of the original work* ● ***Patents*** *(Technical inventions) - a monopoly right granted in return for causing the publication of an invention, preventing others to use it without agreement* ● ***Database rights*** *(Creation & arrangement of data) - legal rights that protect the creation & management of data)* ● ***Design rights*** *(Appearance)* ● ***Trademarks*** ● ***Confidentiality Agreements*** *(Know-how)*	**IP Helpdesk Glossary**
Ownership of results & Joint Ownership	*Results are owned by the beneficiaries that generate them. However, two or more beneficiaries' own results jointly if they have jointly generated them and it is not possible to:* ● *establish the respective contribution of each beneficiary, or*	interTwin Grant Agreement

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[7] https://intellectual-property-helpdesk.ec.europa.eu/regional-helpdesks/european-ip-helpdesk/europe-glossary_en

	• *separate them for the purpose of applying for, obtaining, or maintaining their protection.* *The joint owners must agree — in writing — on the allocation and terms of the exercise of their joint ownership ('joint ownership agreement'), to ensure compliance with their obligations under this Agreement.*	
Access rights for implementing the action	*The beneficiaries must* **grant** *each other* **access — on a royalty-free basis — to background needed to implement their own tasks under the action** *unless the beneficiary that holds the background has — before acceding to the Agreement:* ▪ *informed the other beneficiaries that access to its background is subject to restrictions, or* ▪ *agreed with the other beneficiaries that access would not be on a royalty-free basis.* *The beneficiaries must* **grant** *each other* **access — on a royalty-free basis — to results needed for implementing their own tasks under the action**.	interTwin Grant Agreement
Access rights for exploiting the results	*The beneficiaries must* **grant** *each other* **access — under fair and reasonable conditions — to the results needed for exploiting their results.** *The beneficiaries must grant each other access — under fair and reasonable conditions —* **the background needed for exploiting their results** *unless the beneficiary that holds the background has — before acceding to the Agreement — informed the other beneficiaries that access to its background is subject to restrictions.* ***Requests for access must be made — unless agreed otherwise in writing*** *— up to one year after the end of the action. Access rights for entities under the same control*	interTwin Grant Agreement

Technology Readiness Levels - TRL	**TRL 1** – *basic principles observed* **TRL 2** – *technology concept formulated* **TRL 3** – *experimental proof of concept* **TRL 4** – *technology validated in the lab* **TRL 5** – *technology validated in relevant environment (industrially relevant environment in the case of key enabling technologies)* **TRL 6** – *technology demonstrated in relevant environment (industrially relevant environment in the case of key enabling technologies)* **TRL 7** *system prototype demonstration in an operational environment* **TRL 8** – *system complete and qualified* **TRL 9** – *the actual system is proven in an operational environment (competitive manufacturing in the case of key enabling technologies; or in space)*	**European Commission Annex G. Grant Agreement** [8]
Objectives	*The **goals** of the work performed within the project, **in terms of its research and innovation content.** These will be translated into the **project's activities**. These may range from **tackling specific research questions, demonstrating the feasibility of innovation**, and **sharing knowledge among stakeholders on specific issue**s. The nature of the objectives will depend on the type of action and the scope of the topic.*	**European Commission Horizon Europe Guidelines**
Outcomes	***The expected effects, over the medium term, of projects** supported under a given topic. The results of a project should contribute to these outcomes, f**ostered in particular by the dissemination and exploitation measures** (including the uptake, diffusion, deployment, and/or use of the project's results by direct target groups). **Outcomes generally occur during or shortly after the end of the project***	**European Commission Horizon Europe Guidelines**

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[8] https://ec.europa.eu/research/participants/data/ref/h2020/wp/2014_2015/annexes/h2020-wp1415-annex-g-trl_en.pdf

Impacts	*Wider long-term effects on society (including the environment), the economy and science, enabled by the outcomes of R&I investments (long term). It refers to the specific contribution of the project to the work programme's expected impacts described in the destination. Impacts generally occur sometime after the end of the project.*	**European Commission Horizon Europe Guidelines**

2 Innovation Management and Exploitation Progress (M22)

The **Innovation management plan** is fully described in D2.2 and built around **3 main activities** listed below, to be performed during the project and **their corresponding processes and procedures:**

1. **Understanding the Market, Technological and Political Context** of the project is crucial to providing the necessary market information to incorporate the project solutions.
2. **Capture and identify project results** to push technologies and services to the market including ownership, and associated IP Rights and access strategy
3. **Prepare, monitor, and update exploitation, business, and sustainability plans** in order to ensure the proper uptake of project results to cover expected pathways to impact, while generating the necessary feedback loop back to all other innovation stages of the project.
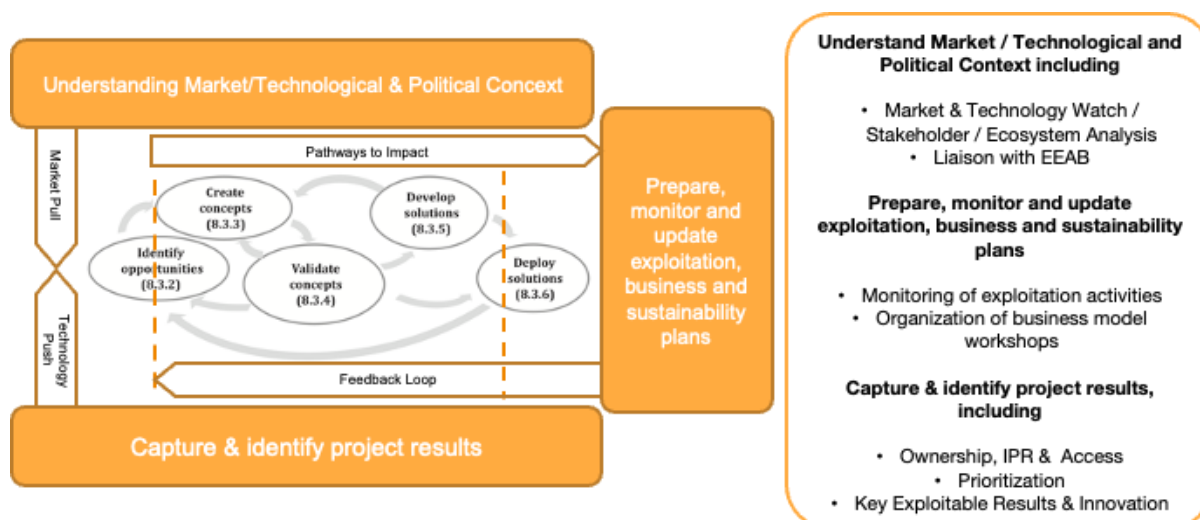

Figure 1 - Main innovation management activities

In the following sections, the progress for each of the activities is provided for the first 22 months of the project.

2.1 interTwin Market, Technological and Political Context Progress (M22)

2.1.1 interTwin Market, Technological and Political Context Progress (M22)

The main market addressed in the interTwin project is the Digital Twins Market. Figure 2 depicts the adjacent market verticals (application domains), horizontals (enabling technologies) and downstream (infrastructure).
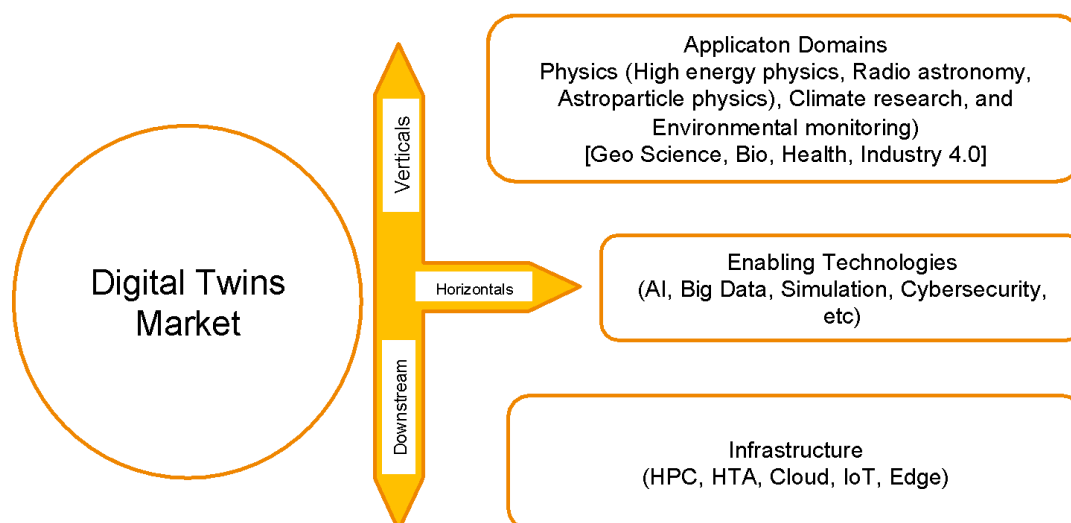
Figure 2 - interTwin Key Markets

The global Digital Twin market size was valued at USD 11.12 billion in 2022, and grew to 16,75 billion in 2023 and is expected to grow at a compound annual growth rate (CAGR) of 35.7% from 2024 to 2030, according to a report by Grand View Research[9]. Other reports also predict even higher CAGRs up to 58.5% and that the market will reach a size of USD 184,5 billion by 2030.[10]

This growth will be boosted by the deployment of enabling technologies for Digital Twins including the Edge, Internet of Things (IoT), artificial intelligence (AI), big data analytics, and cloud computing as these technologies are used to collect, analyse, and manage data from physical assets in real-time, creating a virtual replica of the physical asset.

> Within interTwin AI and Big data technologies play a very relevant role, especially with the simulation needs of the Digital Twins, whereas it takes data from already collected

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[9] https://www.grandviewresearch.com/industry-analysis/digital-twin-market

[10] https://www.accenture.com/us-en/insights/technology/technology-trends-2022

> sources hence IoT is not that relevant during the project, it opens the opportunity for possible extensions or follow up projects depending on the needs on use cases.

Commercial adoption of Digital Twins is happening across various verticals, including manufacturing, healthcare, aerospace, automotive, smart cities, energy and utilities, and construction:

- In the manufacturing sector, they are used to optimize production processes and improve product quality;
- in healthcare, to simulate patient-specific scenarios to aid in diagnosis and treatment planning among others,
- in the aerospace industry, to monitor and optimize the performance of aircraft engines;
- in the automotive industry, to optimize the design and performance of vehicles;
- in smart cities digital twins help in urban planning, infrastructure management and improving the efficiency of city services: in energy and utilities, to monitor and optimize the performance of power plants,
- the efficiency of energy grids or the predictive maintenance of infrastructure; in construction, to improve project management and reduce overall costs.

Nowadays the adoption is expected to span over the traditional domains and to keep increasing at extremely high rates[11]

Geographically, the European digital twin market is also expected to grow substantially (CAGR of 38.1% from 2024 to 2030) also driven by technological advancements and increasing adoption across various industries. The growth can be attributed to the rising adoption of Industry 4.0 technologies and the development of emerging technologies, such as big data analytics, IoT, AI, and Machine Learning (ML), including Germany (CAGR 42,8% from 2024 to 2030) pushed by the strong position in manufacturing or France (CAGR 34,8% from 2024 to 2030) following broad digitalisation efforts.

Key players like Siemens, GE, IBM, and Microsoft are leading across the different verticals: Siemens, a major player providing digital twin solutions across various industries, particularly in manufacturing and industrial automation., GE in the utilities sector, IBM provides digital twin solutions integrated with AI and analytics, targeting diverse industries like automotive, aerospace, and manufacturing, Microsoft, through its Azure platform, offers robust digital twin services that cater to smart buildings, smart cities, and industrial IoT applications.

On the enabling technologies side, NVIDIA is the global leader in AI applications. Its platform NVIDIA Omniverse[12] is widely used for large-scale Digital Twin industrial applications, tailored for GPU-based systems and a complete ecosystem providing

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[11] https://insights.daffodilsw.com/blog/the-future-of-digital-twins
https://www.globenewswire.com/en/news-release/2024/01/25/2816781/0/en/Global-Digital-Twin-Market-Growth-Drivers-Size-Industry-Forecast-to-2028.html
https://www.researchandmarkets.com/reports/5939231/digital-twin-global-market-report#rela4-4787530
[12] https://www.nvidia.com/en-us/omniverse/

technologies and community support. On the infrastructure side, Intel [13] has also been investing significant effort to develop a complete Digital Twin ecosystem or use cases tailored to their Intel Xeon technologies and addressing main verticals (Industry 4.0, Automation, Robotics, Aerospace, etc) and a set of tools and technologies tailored to leverage AI for industrial applications (e,g. Intel SceneScape[14], intelOpenVino[15] or SmartEdge[16]). Also noteworthy are the Hyperscalers, offering end-to-end solutions ready-to-be-used in their own compute environments, e.g. before-mentioned Microsoft Azure platform, Azure Digital Twins a cloud-based platform for developing a digital twin solution that allows to construct full digital representations of physical settings, assets, and systems, as well as a collection of services and tools to help you develop and manage digital twin applications[17]. AWS offers AWS IoT Twin Maker Platform [18], which include a set of services for developing and deploying digital twin systems or apps with twin-like characteristics, or Google Cloud IoT Twinmaker, Google Cloud also offers an ecosystem that allows you to develop, deploy, and manage digital twins. Other cloud vendors, such as T-Systems offers NVIDIA Omniverse, running on a sovereign European cloud platform[19].

On top of commercial initiatives, there are many open-source initiatives and compute and data facilities that are hosted, developed and operated by academia and big research initiatives. interTwin aims to promote and enhance the usage of those systems in order to tackle the technical challenges from Digital Twins ensuring that the investments done in publicly available infrastructure are fully leveraged. While being important to establish links with key industrial players (e.g. NVIDIA), it is also important to develop open-source alternatives to avoid vendor lock-in and promote European technologies.

On the infrastructure side, digital twinning requires an operational compute infrastructure able to operate across the whole compute continuum[20]. While commercial initiatives are providing end-to-end solutions, Edge, IoT, Cloud and HPC are well-established markets. Within Europe there are a large quantity of compute resources used for scientific purposes that need to be adapted to tackle the challenges of Digital Twins. EGI has been providing world-class infrastructure for data-intensive computing to scientific communities (along with private and public sectors) – representing over 95k

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[13] https://www.intel.com/content/www/us/en/edge-computing/what-is-a-digital-twin.html

[14] https://www.intel.com/content/www/us/en/developer/tools/scenescape/overview.html

[15] https://www.intel.com/content/www/us/en/developer/tools/openvino-toolkit/overview.html

[16] https://www.intel.com/content/www/us/en/edge-computing/smart-edge.html

[17] https://xmpro.com/microsoft-azure-digital-twins-everything-you-need-to-know/,

[18] https://aws.amazon.com/blogs/iot/edge-to-twin-a-scalable-edge-to-cloud-architecture-for-digital-twins/
https://docs.aws.amazon.com/iot-twinmaker/latest/guide/what-is-twinmaker.html

[19] https://www.telekom.com/en/media/media-information/archive/t-systems-announces-digital-twin-offering-powered-by-nvidia-omniverse-1051446

[20] https://eucloudedgeiot.eu/enabling-technologies-for-the-compute-continuum-what-should-europes-priorities-be/

users. EuroHPC[21] has been deploying top500 supercomputing infrastructure available for scientific research. Its scope has recently extended to tackle future AI challenges by the creation of the so-called -AI-Factories[22]. interTwin is tackling all those aspects by federating IoT, Cloud, HTC, HPC (and EuroHPC) to increase their usage for Digital Twin applications.

Digital Twins for Science are also becoming increasingly useful in science because they allow researchers to simulate complex systems in changing environments and predict how they will behave under different conditions while being able to adjust depending on real-time gathered data. This can help researchers optimize their experiments, improve their understanding of complex phenomena, and develop more effective strategies for managing environmental systems.

Within interTwin market verticals, the main scientific domains addressed are Physics, including High Energy Physics, Radio Astronomy and Astro Particle Physics, Climate research and environmental monitoring. All application domains are well-represented by key research infrastructures representing a large number of scientific communities. Within high-energy physics the Large Hadron Collider (LHC) is one of the largest scientific instruments ever built. Since opening up a new energy frontier for exploration in 2010, it has gathered a global user community of about 9000 scientists working in fundamental particle physics.[23] Including four major biggest particle detector experiments ATLAS[24] , CMS[25], ALICE [26]and LHCb[27]. interTwin is expected to contribute to the High Luminosity upgrade of the LHC (HL-LHC) expected by 2030. Challenges are tackled in the use cases under WP4.1 – A Digital Twin for Lattice QCD simulation [28]and WP4.2 - A particle detector data-driven Digital Twin for High-Energy Physics[29]. Astroparticle physics is represented by the VIRGO collaboration[30], that is composed of 169 Institutions across 18 international countries, and its expected research infrastructure the Einstein Telescope. Within interTwin a Use Case is developed under WP4.4. VIRGO Noise Detector DT. Within RadioAstronomy domain, huge community from the operations and analysis of telescopes such as MeerKat (or in preparation of the next generation of SKA (Square Kilometer Array) that will become operational 2028 , that includes more than 100 organizations in 20 countries world-wide distributed in Europe, Africa, Australia, Canada,

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[21] https://eurohpc-ju.europa.eu/index_en

[22] https://digital-strategy.ec.europa.eu/en/policies/ai-factories

[23] https://e-publishing.cern.ch/index.php/CYRM/issue/view/127

[24] https://home.web.cern.ch/about/experiments/atlas

[25] https://home.web.cern.ch/about/experiments/cms

[26] https://home.web.cern.ch/about/experiments/alice

[27] https://home.web.cern.ch/about/experiments/lhcb

[28] https://www.intertwin.eu/intertwin-use-case-lattice-qcd-simulation

[29] https://www.intertwin.eu/intertwin-use-case-a-particle-detector-data-driven-digital-twin-for-high-energy-physics

[30] https://www.virgo-gw.eu/

etc. Within interTwin a Use Case is developed under WP4.3 - A Digital Twin to simulate 'noise' in Radio Astronomy [31].

While high-energy-physics, astrophysics and radio astronomy domains are very scientific focused aiming mainly to optimize the usage of infrastructures to facilitate and deliver scientific impact, environmental use cases have a high potential to deliver societal benefits.

Environmental use cases are developing digital twins on Climate Change, Climate Adaptation and Extreme Weather events (such as storms, fire, droughts, floods). There are large communities and research infrastructures working in these domains. Within interTwin, ENES (European Network for Earth System Modeling)[32], GEO (Group on Earth Observation)[33] and the EARSeL (European Association of Remote Sensing Laboratories[34], PANGEO[35], ENVRI[36] are represented by project partners, and provide data and tools. Alltogether represent hundreds of organizations that have been delivering major scientific research over the last 20 years. Environmental domain is closer to market, as such, some commercial vendors have developed platforms to tackle digital twins of Earth Systems – such as NVIDIA Omniverse[37]. Within Europe, one of the biggest political endeavours is Destination Earth (DestinE[38]), a flagship initiative to develop a highly-accurate digital model of the Earth (i.e. a digital twin of the Earth) to model, monitor and simulate natural phenomena, hazards and the related human activities. DestinE is an essential pillar of the European Commission's efforts towards the Green Deal [39]and Digital Strategy[40]. interTwin aims to contribute to such a global effort. Environmental use cases are developed under WP4.5, WP4.6 and WP4.7. Deploying FloodAdapt, a digital twin for flood impact modelling, anywhere on Earth[41], A Digital Twin for Flood Early Warning in coastal and inland regions[42], A Digital Twin for Drought Early Warning in the Alps[43], A Digital Twin for projecting wildfire danger due to climate change[44], Extreme rainfall,

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[31] https://www.intertwin.eu/intertwin-use-case-a-digital-twin-to-simulate-noise-in-radio-astronomy

[32] https://is.enes.org/index.html

[33] https://earthobservations.org/

[34] https://earsel.org/

[35] https://pangeo.io/

[36] https://envri.eu/

[37] https://www.engineering.com/story/nvidia-omniverse-makes-the-biggest-digital-twin-on-earth

[38] https://destination-earth.eu/

[39] https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en/

[40] https://commission.europa.eu/system/files/2020-02/communication-shaping-europes-digital-future-feb2020_en_4.pdf

[41] https://www.intertwin.eu/intertwin-use-case-deploying-floodadapt-a-digital-twin-for-flood-impact-modelling-anywhere-on-earth

[42] https://www.intertwin.eu/intertwin-use-case-flood-early-warning-in-coastal-and-inland-regions

[43] https://www.intertwin.eu/intertwin-use-case-a-digital-twin-for-drought-early-warning-in-the-alps

[44] https://www.intertwin.eu/intertwin-use-case-a-digital-twin-for-projecting-wildfire-danger-due-to-climate-change

temperature and wind - weather extremes as a result of climate change[45]. Environmental use cases have a huge social impact, and as such, some further key stakeholders are policymakers or public administrations that can translate project results into policy actions.

2.1.2 interTwin Technology Value Chain

As depicted in the Figure 3, the main steps in the technology value chain are:
- Infrastructure represents the federated data and compute resources involved in modelling and simulation tasks, including HPC, HTC, Cloud, Quantum computing resources and Data repository and its Authentication and Authorization Infrastructure (AAI), Orchestration and Federated Data Management.
- Digital Twin Core modules offer horizontal capabilities to facilitate the creation and operation of data-intensive and compute-intensive DT applications including workflow composition modules supporting big data analytics, AI and Data Fusion, Quality Verification and Real-time data acquisition and processing.
- Digital Twin Thematic Modules are add-ons providing capabilities tailored to the needs of specific groups of applications that can become part of the core modules if they can be in the interest of further communities.
- Application/Scientific Domain are the actual use case implementations of Digital Twins for the different scientific domains of the project
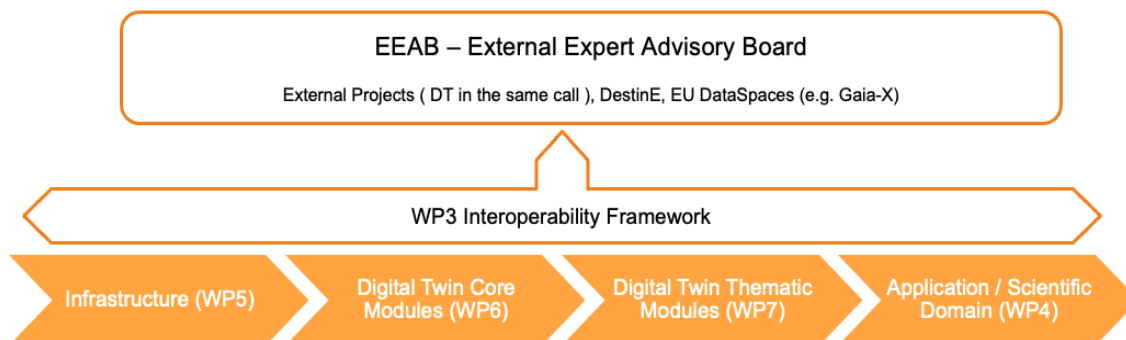
Figure 3 - interTwin Technology Value Chain

Target Users:

- **DT Developers** interact with interTwin DTE, seen as PaaS, developing DT applications and occasionally thematic modules tailored to the needs of specific user communities. (D3.1, D3.3 and D3.5)
- **DT Users** access the DTE as a SaaS via the DT applications developed by the DT developers. An end user can choose an "out of the box" DT application and connect it to its use case (physical twin) or configure the needed parameters for their experiments. (D3.1, D3.3 and D3.5))

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[45] https://www.intertwin.eu/intertwin-use-case-extreme-rainfall-temperature-and-wind-weather-extremes-as-a-result-of-climate-change

- **The DT Infrastructure Provider** provides computational resources, storage, and eventual connection with the physical twin living in the real world. (D3.1, D3.3 and D3.5 and WP5 deliverables))

DTE Technology providers are mainly project partners within interTwin. They can also eventually become target users (e.g. when provider of Thematic Modules needs to use DTE Core and Infrastructure modules)

Infrastructure (WP5)
- <u>Description:</u> Infrastructure stands for the federated data and compute resources involved in modelling and simulation tasks, including HPC, HTC, Cloud, Quantum computing resources and Data repository and its Authentication and Authorization Infrastructure (AAI), Orchestration and Federated Data Management. This block represents the underlying data infrastructure and server orchestration capabilities. This includes storage, processing, and management of data related to DTs, as well as the orchestration of servers to ensure efficient execution of all operations in the DTE
- <u>Lead Users:</u> DT infrastructure providers (such as System Administrators) and DT developers aiming to build DT services leveraging compute and data infrastructures
- <u>Components:</u> interLink, Teapot, Rucio, FTS, PaaS Orchestrators, APEL Accounting

Digital Twin Core Modules (WP6)
- <u>Description:</u> Digital Twin Core modules offer horizontal capabilities to facilitate the creation and operation of data-intensive and compute-intensive DT applications including workflow composition modules based on big data analytics, AI and Data Fusion, Quality Verification and Real-time data acquisition and procession. This block encompasses essential functionalities necessary for maintaining the integrity and efficiency of the DTE. Core capabilities include quality control (QC) and verification functions, workflow generation capabilities, and data acquisition and processing using Machine Learning (ML). Developers can interact with these core functionalities to fine-tune the operation of DT Applications, ensuring that the applications perform as intended. (D3.1, D3.3 and D3.5 and WP6 deliverables))
- <u>Lead Users:</u> Mainly DT Developers needing to interface with interTwin DTE core and thematic modules. Noteworthy to mention not all core modules are necessary for every DT application, e.g. they depend on the different infrastructures, environments and specific needs (e.g. AI/ML, openEO, etc) that would require users to have that specific domain expertise.
- <u>Components:</u> OSCAR, DCNIOS, PyOphidia, yProv, SQAaaS, SQAaaS Github Actions, SQAaaS CLI, Infrastructure Manager, Configuration Artifacts, Big Data Analytics TOSCA templates, itwinai, openEO.

Digital Twin Thematic Modules (WP7)

- <u>Description:</u> Are add-ons providing capabilities tailored to the needs of specific groups of applications that can become part of the core modules if they are of interest to other communities. The Thematic Modules form the second block, providing specific functionalities that DT Applications use to execute their processes and achieve their

objectives. These modules cater to specialised requirements, and they can vary based on different application areas or themes. Developers have access to these modules to customise the DTs according to specific needs. (D7.1, D7.2)

- Lead Users:
  - DT Developers: which will be using the DT engine components (thematic and core modules) to build a new DT application. Developers will directly access the thematic modules described here and can customise them, as well as the workflow, to meet specific needs for new users. (D7.1, D7.2)
  - DT Users - End-users (scientists, policy makers, stakeholders): which will be directly using the DTs applications to be implemented in WP4. The scope of the DT applications in interTwin is quite broad. Some users will access the data and visualisation capabilities offered by the application with the aim of collecting relevant findings from a scientific standpoint for some of them, whereas others will have a stronger focus on decision making and planning. E.g. DT applications that enable the simulation of what-if scenarios and sensitivity analyses to understand for example how anthropogenic forcings can impact Climate Extreme Events in future projection data. (D7.1, D7.2)
- Components:
  - Physics: openQxD, normflow, PulsarDT, PulsarDT++, PulsarRFI_Gen, PulsarRFI_NN, GlitchFlow, 3DGAN
  - Environmental: ML TC Detection, ML4Fires, eddiesGNN, xtclim, downscaleML, CompEVPoEToE, openeo-processes-dask, openeo-pg-parser-network, raster-to-stac, FloodAdapt, HydroMT-SFINCS, HydroMT-FIAT, SFINCS, Delft-FIAT, Hython Wflow_Svm Hydrological Model

Application / Scientific Domain (WP4)

- Description: are the actual use case implementations of Digital Twins for the different scientific domains of the project. This block represents the software applications which developers use to create, manage, and configure the Digital Twins (DTs), and which DT Users use to execute the DTs for their research or decision-making purposes (D4.1, D4.2).
- Lead Users:
  - DT developers: the current deliverable provides them with an opportunity to gain insight into different components, data integration strategies, and computational models required to build an effective digital twin. It would allow them to incorporate new features, leverage components, improve scalability, support evolving problems over time, and ensure interoperability.
  - DT users (end users): the specified deliverable facilitates data sharing, integration, and analysis among various stakeholders and scientists. By establishing a common framework for communication, researchers and stakeholders will be able to exchange information, validate models, and collaboratively address climate change impacts and suggest mitigation measures.

DT Applications: All the different DTs: Early warning for Extreme events. WildFire Hazard Map Generation, Tropical Cyclone Detection, Extreme Events impacts, Radio Astronomy, High Energy Physics, Lattice QCD, Gravitational Wave - Astrophysics[46].

2.1.3 Liaison with External Stakeholders – Stakeholder management

In D2.3 the different types of stakeholders are described. As part of the contextual analysis, a list of specific institutions, organizations, research infrastructures and projects has been compiled and a short assessment of their relevance for interTwin and expected Dissemination, Exploitation and engagement actions has been considered. The following table summarizes the main findings. Within D3.1 and D3.4 the technical uptake is also assessed for them. Some of them

Research infrastructures such as, ENES, members of the earth observation community active in GEO (Group on Earth Observation) and EARSeL (European Association of Remote Sensing Laboratories), HL-LHC, PANGEO, Einstein Telescope (ET), VIRGO or ENVRI are key stakeholders for the different DT Applications. They provide the necessary data, requirements and they are expected to leverage and adopt the DT Applications to improve their services.

Research Projects such as, EGI-ACE, EOSC Synergy, C-SCALE, RAISE CoE that are already finalized have provided some initial infrastructure, technologies and tools that are being used, extended and enhanced by interTwin project. Other research project initiatives DT-Geo, BioDT, DT-Iliad, AquaInfra, EDITO Infra, with shared objectives offer collaboration opportunities for standardization and interoperability, to share the results across their communities and marketplaces such as AI-On-Demand (AI4Europe), Aqua infra, or for the use and re-use of technologies or for the use or re-use of specific interTwin components (e.g. DECICE interested in the adoption of interLink or AI4EOSC of itwinai)

Major European Initiatives (Destination Earth), EuroHPC, EOSC do not only offer the funding but long-term direction and strategy for project results adoption on the policy side. interTwin is also seeking the opportunity to influence roadmapping initiatives (under SPECTRUM project) or get in contact with multiplier communities and interest groups such as HiPEAC, ETP4HPC, etc.

The concrete listing of institutions and activities, including the type of initiative, role, market domains, relevance for interTwin and dissemination and exploitation actions is provided in Annex 1.

2.1.4 External Expert Advisory Board (EEAB). Description and Progress

As described in D2.2 EEAB has the following main purpose and responsibilities:

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[46] https://www.intertwin.eu/use-cases

- Advises the Technical Coordination Board (TCB) on the project technical architecture and implementation plan. It draws membership from Digital Twin innovators and adopters from different sectors.
- Reviews blueprint architectures relevant to the specific scientific domains of the project (such as Destination Earth)– from an implementation point of view
- Validates and makes sure that what the project is delivering is useful in broader application domains.

EEAB is chaired by the Innovation Manager, will be appointed, and steered by the Technical Coordination Board and is composed of between 5 and 7 Members. Ideally EEAB members should be the same throughout the project, however the TCB may propose new members or substitute members depending on their availability and the technological status and evolution throughout the project.

Key Expertise of the EEAB members includes:

- Experts across the interTwin value chain - Infrastructure, Digital Twin Developers, Application Developers – e.g., Project coordinators or Key Representatives of the rest of Digital Twins Projects in the same interTwin European Commission call: DT-GEO, BioDT, eBRAIN-Health). This is a lightweight, very efficient, and effective way of cross-collaboration between projects.
- End user experts across scientific domains for each of the use cases – e.g., High energy physics, Radio astronomy, Astroparticle physics, Climate research, and Environmental monitoring.
- Experts in adjacent application / scientific domains (other than interTwin), especially those which have already relevant industrial adoption or from the other Digital Twins Projects– such as Industry 4.0, Geo-sciences, Bio or Health.

Main duties of EEAB Members are expected to be as lightweight as possible. EEAB members are highly renowned experts in the community, and no economic compensation is expected for their contribution – other than covering travel costs.

The main duty is to provide feedback – to be given during dedicated meetings (F2F or virtual).

- Any necessary material (agenda, executive summaries) is provided in advance. Any further material – such as deliverables, papers, and presentations can also be provided upon interest.
- During the meetings, EEAB members are required to provide feedback in specific Q&A (after presentations or on a specific discussion session)
- Minutes from the meeting are taken by a rapporteur from project representatives and shared with the EEAB members for validation.

In the case of not being able to attend – feedback is collected by one-on-one interaction (by telco, interview, etc).

Other forms of feedback collection such as survey/semi-structured questionnaire or open-ended questions or sending back a written report can also be considered on project needs and EEAB members availability.

Moreover, support for dissemination and exploitation is also requested on a best effort basis.

- Dissemination wise – EEAB member are asked to provide publishable information for interTwin project website (such as a short CV or publishable quotes along the project), providing content, giving a presentation to the consortium or at an event, participating in public discussion, etc.
- Exploitation wise – becoming early adopter or providing ideas or contacts for early adopters, providing ideas on business models or other potential exploitation activities.

EEAB Members are proposed by Coordinator or Interested Partners and accepted by the TCB. Official invitations are to be sent by PMO/Project Coordinator/Innovation Manager backed by Proposing Partner. EEAB Members will need to sign a Letter of Intent or accept the Terms of Reference.

EEAB Members are expected to attend 1 meeting per year (3 in total). When possible, meetings are physical, co-located with flagship events (e.g., at the EGI conference). If not possible, online meetings are also possible– or any other channels will be used). Informal interactions are also expected, e.g. when participating in major events and conference

Table 2 shows the list of expected meetings:

Table 2 - EEAB expected meetings

Meetings	Timeline	Scope
1st EEAB Meeting – co-located with EGI Conference 2023	June 2023	Present the early version of the Blueprint deliverable & gather feedback before the review
2nd EEAB Meeting - Online	June 2024	Present a 1st complete picture of the Digital Twin Engine & early version of Use Cases
3rd EEAB Meeting - co-located with EGI Conference 2024	October 2024	Gather feedback to incorporate to the final release. Aim for exploitation -focus on end users & potential adopters and impact

Complementary approaches are used for gathering feedback in the meetings, which include:

- Inviting EEAB Members to take part in whole F2F meeting presentations. This enables the project to provide a better understanding of the in-depth status of the project and hence be able to receive better quality feedback. On the other side this approach requires a more time-consuming commitment of the EEAB members (usually 1-2 days) and possibly some parts of the project are not that interesting for the members depending on their expertise.

- Preparing a specific session that includes presentations tailored to the EEAB members (1-2 hours). This is the less time-consuming option for the EEAB members – but it may require preparation (providing materials in advance, reading, etc) in order to provide meaningful feedback.
- Preparing a specific consultation meeting for EEAB members – including a whole set of presentations to foster discussion & feedback (half day). This is an in-between solution between the approaches.

Presentations are open (public) by default – restricted as necessary. Hence, presentations should be public/open (without sharing confidential information). Design & architecture should be open -so it can be taken as a reference. If for any reason it is necessary to present any confidential information – EEAB members are covered under an NDA signed on an individual basis or on an institutional basis. .

Travel costs are expected to be covered by the project (taken from the budget to cover costs for External Travel). EEAB members will comply with the reimbursement policies of the project coordinator, EGI.

Feedback collected from EEAB is translated into actions to be performed by the project. Any decision related to how the feedback is incorporated into the project and the related actions– will follow the corresponding voting rules of the corresponding decision board (TCB for the incorporation of the technical feedback and the General Assembly for any higher-level project decision emerging from the feedback). Any further external feedback should also be collected at events or by sending out surveys or questionnaires to relevant stakeholders.

Selected EEAB Members:

Table 3 - EEAB members

Name	Institution / Projcet	Key Expertise / Scientific Domain	Expectation in EEAB
	[Industry, SME, Research Institution, Academia, Policy Making] / DT-GEO, BioDT, eBRAIN-Health, others?]	[High energy physics, Radio astronomy, Astroparticle physics, Climate research, and Environmental monitoring] [Geo Science, Bio, Health, Industry 4.0]	[Expected contribution]
Ramon Carbonell / Arnau Folch	CSIC / DT-GEO	Geo Science	Alignment between TECH01-01 projects

			/ Project cross-pollination
Anabela de Oliveira	INEC	Bio / Marine	Potential DT-use case
Marian Bubak	EDITH Project	Health	Data Sensitive Requirements assessment for DT Usage Cross-Domain
Valentine Anantharaj	ORNL	Infrastructure	Link to US know-how

At the beginning of the project Zimming Zhao and Shawn de Wijt were also invited, however as NDA was required after the first year – their organizations would not comply with the provisions of interTwin, and therefore could not continue being shortlisted as EEAB members. Their feedback is still valuable and considered by the project as part of the external feedback.

2.1.4.1 1st EEAB Meeting – co-located with EGI Conference 2023 (June 2023)

First EEAB meeting was organized in June 2023 during the EGI Conference 2023. It included the participation of 3 experts

- Anabela de Oliveira - Coastal Digital Twin
- Zhiming Zhao - also participating in BioDT
- Ramon Carbonell (Online) – Co-Coordinator of DT-GEO

They were introduced to the project, and presented the key activities such as the BluePrint Architecture and Interoperability aspects. They provided the first feedback which was taken into consideration for the 1st Software release. Some suggestions were to think the architecture not only on AI/ML based models but also process-based or hybrid models, to think in the quantification and validation, and to think about the importance of user interaction and the need to discuss on how a to interface with the user.

2nd EEAB Meeting – Online (June 2024)

Second EEAB meeting was organized June 2024 online. It included the participation of 4 experts

- Anabela de Oliveira - LNEC
- Valentine Anantharaj - ORNL
- Arnau Folch - CSIC
- Marian Bubak - EDITH

They were given a status update of the project including the newer versions of the Blueprint Architecture and Interoperability. 1st release of SW components was presented including their integration status and the progress of the Key Exploitable Results. They provided feedback on potential dissemination and exploitation opportunities such as publications and training opportunities, ideas to foster the cross-collaboration between projects, and feedback coming from the adoption of digital twins in the US.

2.2 interTwin Project Results & IP Management Progress (M22)

2.2.1 interTwin background

One of the first duties of the project was to provide support to gather the background information of the partners to feed the consortium agreement. The list has been compiled and stored at the corresponding confluence repository.[47] In M22 the number of identified elements increased to 74. For all of them, the access information for implementation and exploitation has been provided together with the WP under which those elements are needed and the contact person and link for accessing those open elements.

2.2.2 interTwin results

The project objectives[48] and foreseen Key Exploitable Results (KERs)[49] each have their own associated stakeholder engagement level. Presented below are the baseline results, KERs, outputs and impacts, as described in the DoA. The KERs will serve as the basis to structure the concrete Exploitation activities proposed further in this plan and in the following iterations (M36). In M22 the number of identified results has increased to 42 components and subcomponents and 6 Key Exploitable Results. 17 of them are new developments, and 25 are extensions, modifications or improvements over pre-existing codes.

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[47] https://confluence.egi.eu/display/interTwin/1.+Background (restricted to Consortium members)
[48] interTwin Project Objectives
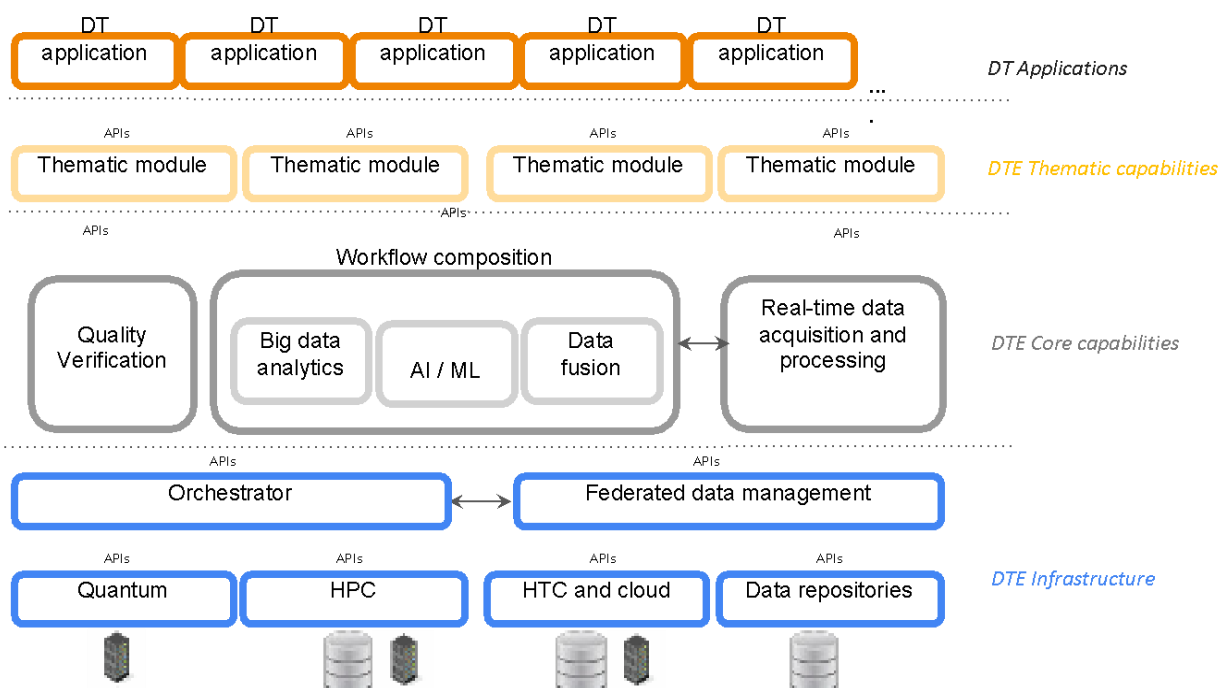[49] interTwin Key Exploitable Results

Figure 4 - interTwin Building Blocks

Specific provisions on IP Managment. As explained in D2.2 and the DoA, each partner will own the results they have generated (unless otherwise stated in a written agreement). As such each partner is responsible to apply the necessary Intellectual Property Right to each of their results. Expected results include mainly the generation of software components, know-how and services related to those and standardization efforts linked to their interoperability. Due to the modular approach of the project, no joint ownership (as per definition of the Grant Agreement) is expected for the digital twin engine, but some of the components are jointly owned by the project participants.

Different modules and components from the Digital Twin Engine (DTE) can be combined to build the Digital Twins in the use cases. As such, in order to facilitate access to all the components, it is foreseen that the majority of software results and modules will be licensed under free and open source software licence protections, whereas any written results (e.g. documentation) will be shared under creative commons CC BY. If there is any legitimate issue needing to ensure confidentiality, necessary agreements will be arranged (NDA, license, etc), e.g to ensure protection of personal data or privacy constraints.

Specific provisions on software: Particular attention is paid for integration of services into external marketplaces such as the EOSC and AI4EU as it requires seamless integration of IP from numerous sources (including, back, side and foreground from the project beneficiaries) -and as such, the licensing scheme for each of the components is being assessed. For the reasons outlined above, the strategy for the software code developed by the project is to have it licensed under permissive open-source licenses (whenever it is possible). For outputs that are improvements to existing software, the improvement will be freely assigned to the owners of the background IP for incorporation therein and will have the same permissive open license as the software itself. Although

copyright will exist in the source code generated during the project, this will not be asserted for research or future commercial use to facilitate the uptake of those.

Specific provisions on other results: All other exploitable project results (data, framework, publications, guidelines, resources) will be made available under creative commons license and adhere, to the extent possible, to the Horizon Europe Open Access Policy for all peer reviewed scientific publications self-archived as open access via Zenodo (if possible, published in an open access journal). As explained before, in case of legitimate interest, confidentiality is preserved by setting the necessary conditions under NDA and license agreements. For instance, despite the open nature of the project, NDAs have been requested for the EEAB members – in order to ensure knowledge can be shared without restrictions and hence to be able to get as good feedback as possible.

Results Ownership List

Table 4 - Results Ownership List

Results Ownership List	Single or joint ownership result	Result Owners	Will the owners exploit the result?	In which form will the result be made available to other consortium members and/or third parties?	Does the exploitation of the results require access to consortium members background?	If yes- Measures taken/envisaged to give access to the background required for exploitation	Does the exploitation of the results require access to third party IPR?	If yes- Measures taken/envisaged to give access to the required IPR
01. Interdisciplinary Digital Twin Engine	Single	EGI Foundation	Yes	Open Source	Yes	Open Source	Yes	Open Source
02 .Interoperability Framework: Guidelines, Specifications, and Blueprint Architecture	Joint	Collaborative work of all project partners having contributed to the results	Yes	Open Access	No	N/A	No	N/A
03. Toolkit for AI workflow and method lifecycle management	Single	Partner owning the SW components & tools	Yes	Open Source	Yes	Open Source	Yes	Open Source
04. Quality Framework	Joint	CSIC/ LIP / UPV	Yes	Open Access Open Source Free License	Yes	Open Source	Yes	Open Source
05. DTE federated infrastructure integrated with EOSC and EU Data Spaces	Single	Owners of each of the subcomponents	Yes	Open Source	Yes	Open source	Yes	Open Source
06. interTwin Open Source Community	Joint	Collective work of all project partners	Yes	Open Access Open Source	Yes	All components stored in the github under open source license. All documentation under CC. Open access to GitHub	Yes	Access as specified by each specific component

07. OSCAR. Extensions/Development or Modifiactions	Single	UPV	Yes	Open Source Other - as as service	Yes	Access under Open Source license	Yes	Access under Open Source license
08. dCNiOS. New development	Single	UPV	Yes	Open Source Other - as as service	Yes	Access under Open Source license	Yes	Access under Open Source license
09. PyOphidia. Extensions/Development or Modifiactions	Single	CMCC	Yes	Open Source Other - as asservice	Yes	Access under Open Source license	Yes	Access under Open Source license
10. yProv. Extensions/Development or Modifiactions	Single	UNITN	Yes	Open Source Other - as as service	Yes	Access under Open Source license	Yes	Access under Open Source license
11. SQAaaS Platform. Extensions/Development or Modifications	Joint	UPV, LIP, CSIC/UNICAN	Yes	Open Source Other - as as service	Yes	Access under Open Source license	Yes	Access under Open Source license
12. SQUaaS GitHub action. New Developement	Joint	CSIC/UNICAN	Yes	Open Source Other - as as service	Yes	Access under Open Source license	Yes	Access under Open Source license
13. SQUaaS GLI. New Developement	Joint	CSIC/UNICAN / LIP	Yes	Open Source Other - as as service	Yes	Access under Open Source license	Yes	Access under Open Source license
14. Infrastructure Manager. Extensions/Developments or Modifications	Single	UPV	Yes	Open Source Other - as as service	Yes	Access under Open Source license	Yes	Access under Open Source license
15. Configuration Artifacts. New Developement	Single	UPV	Yes	Open Source	Yes	Access under Open Source license	Yes	Access under Open Source license
16. Big Data Analytics TOSCA templates. New Developement	Single	UPV	Yes	Open Source	Yes	Access under Open Source license	Yes	Access under Open Source license
17. ItwinAI. New Developement	Joint	CERN / FZJ	Yes	Open Source	Yes	Access under Open Source license	Yes	Access under Open Source license
18. openEO. Extensions/Development or Modifiactions	Joint	EURAC, EODC, WWU, Munster	Yes	Open Source	Yes	Access under Open Source license	Yes	Access under Open Source license
19. interLink. New Development	Single	INFN	Yes	Open Source	Yes	Access under Open Source license	Yes	Access under Open Source license
20. Teapot. New Development	Single	DESY	Yes	Open Source	Yes	Access under Open Source license	Yes	Access under Open Source license
21. ALISE. New Development	Single	KIT	Yes	Open Source	Yes	Access under Open Source license	Yes	Access under Open Source license

22. FTS3. Extensions/Development or Modifiactions	Single	CERN	Yes	Open Source	Yes	Access under Open Source license	Yes	Access under Open Source license
23. Rucio. Extensions/Development or Modifiactions	Single	CERN	Yes	Open Source	Yes	Access under Open Source license	Yes	Access under Open Source license
24. INDIGO. PaaS Orchestrator. AI Based Orchestrator. Extensions/Development or Modifiactions	Single	INFN	Yes	Open Source	Yes	Access under Open Source license	Yes	Access under Open Source license
25. APEL Accounting. Extensions/Development or Modifiactions	Single	STFC UKRI	Yes	Open Source	Yes	Access under Open Source license	Yes	Access under Open Source license
26. openQxD. Extensions/Development or Modifiactions	Single	CSIC	Yes	Open Source	Yes	Access under Open Source license	Yes	Access under Open Source license
27. normflow. Extensions/Development or Modifiactions	Single	ETHZ	Yes	Open Source	Yes	Access under Open Source license	Yes	Access under Open Source license
27. PulsarD. Extensions / Developments or Modifications	Joint	MPIfR HTW Berlin PUNCH4NFDI UHEI	Yes	Open Source	Yes	Access under Open Source license	Yes	Access under Open Source license
28. PulsarDT++. Extensions / Developments or Modifications	Joint	MPIfR HTW Berlin PUNCH4NFDI UHEI	Yes	Open Source	Yes	Access under Open Source license	Yes	Access under Open Source license
29. PulsarRFI_Gen. Extensions / Developments or Modifications	Joint	MPIfR HTW Berlin PUNCH4NFDI UHEI	Yes	Open Source	Yes	Access under Open Source license	Yes	Access under Open Source license
30. ML-TC Detection. Extensions / Developments or Modifications	Joint	CMCC/UNITN	Yes	Open Source	Yes	Access under Open Source license	Yes	Access under Open Source license
31. ML4Fires. New Development	Single	CMCC	Yes	Open Source	Yes	Access under Open Source license	Yes	Access under Open Source license
32. eddiesGNN. New Development	Single	UNITN	Yes	Open Source	Yes	Access under Open Source license	Yes	Access under Open Source license

33. xtclim. Extensions/Developments or Modifications	Single	CERFACS	Yes	Open Source	Yes	Access under Open Source license	Yes	Access under Open Source license
34. downscaleML. New Development	Single	EURAC	Yes	Open Source	Yes	Access under Open Source license	Yes	Access under Open Source license
35. CompEVPoEToE. New Development	Single	CNRS	Yes	Open Source	Yes	Access under Open Source license	Yes	Access under Open Source license
36. openeo-processes-dask. Extensions/Developments or Modifications	Joint	EODC, EURAC	Yes	Open Source	Yes	Access under Open Source license	Yes	Access under Open Source license
36. openeo-pg-parser-networkx. Extensions/Developments or Modifications	Joint	EODC, EURAC	Yes	Open Source	Yes	Access under Open Source license	Yes	Access under Open Source license
38. raster-to-stac. New Developement	Single	EURAC	Yes	Open Source	Yes	Access under Open Source license	Yes	Access under Open Source license
39. FloodAdapt. Extensions/Developments or Modifications	Single	Deltares	Yes	Open Source	Yes	Access under Open Source license	Yes	Access under Open Source license
40. HydroMT-SFINCS. Extensions/Developments or Modifications	Single	Deltares	Yes	Open Source	Yes	Access under Open Source license	Yes	Access under Open Source license
41. HydroMT-FIAT. Extensions/Developments or Modifications	Single	Deltares	Yes	Open Source	Yes	Access under Open Source license	Yes	Access under Open Source license
42. Hython Wflow_sbm Hydrological Model. Extensions/Developments or Modifications	Single	Deltares	Yes	Open Source	Yes	Access under Open Source license	Yes	Access under Open Source license

2.2.3 Key Exploitable Results Progress (M22). Components & IP Management

KER1: Interdisciplinary Digital Twin Engine

Description: A software platform that provides generic and tailored functional modules for data-driven and process-based modelling to facilitate the development and deployment of Digital Twins that address scientific problems in different domains.
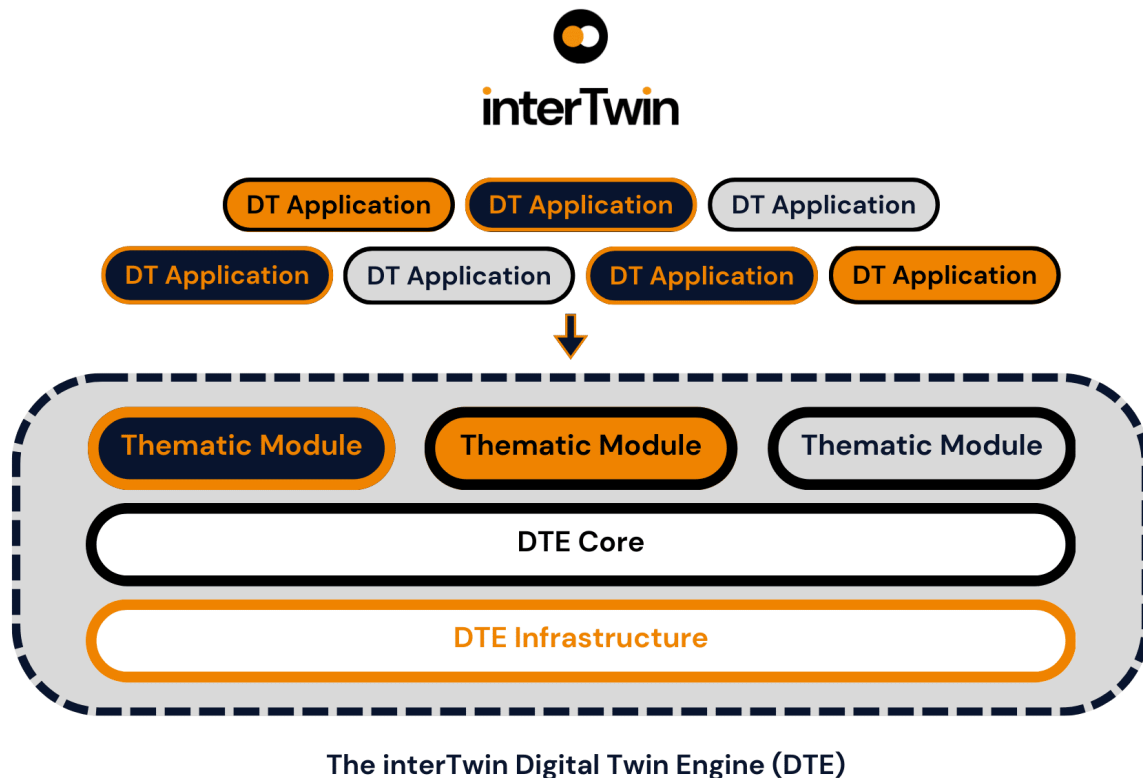

The interTwin Digital Twin Engine (DTE)

Figure 5 - interTwin DTE

The interTwin Digital Twin Engine (DTE) is an open-source integrated platform underpinned by open standards, APIs, and protocols. It facilitates the development and implementation of specific Digital Twins. The DTE supports the setup, configuration and exploitation of Digital Twins.

The interTwin DTE consists of the layers explained before,
- The DTE Infrastructure Modules provide specific capabilities for implementing Digital Twins, such as federated data and computing resources needed to run modelling and simulation tasks on the computing infrastructure
- The DTE Core Modules offer cross-domain capabilities, simplifying the creation and operation of data-intensive and compute-intensive DT applications
- The DTE Thematic Modules (currently: Environment and Physics) are add-ons providing capabilities tailored to the needs of specific application groups. They

implement core functionalities for a DT but domain specific. They can evolve into core modules following successful adoption by multiple resource communities across different domains.

The Digital Twin Applications are user-centric implementations of DTs workflows, leveraging the DTE's capabilities to meet specific use case requirements. It encompasses all the components and subcomponents of the project that are not part of the Digital Twins

Following is the summary of all the components of the DTE:

Thematic Modules:
- Physics: openQxD, normflow, PulsarDT, PulsarDT++, PulsarRFI_Gen, PulsarRFI_NN, GlitchFlow, 3DGAN
- Environmental: ML TC Detection, ML4Fires, eddiesGNN, xtclim, downscaleML, CompEVPoEToE, openeo-processes-dask, openeo-pg-parser-network, raster-to-stac, FloodAdapt, HydroMT-SFINCS, HydroMT-FIAT, SFINCS, Delft-FIAT, Hython Wflow_Svm Hydrological Model

DTE Core Modules:
- OSCAR, DCNIOS, PyOphidia, yProv, SQAaaS, SQAaaS Github Actions, SQAaaS CLI, Infrastructure Manager, Configuration Artifacts, Big Data Analytics TOSCA templates, itwinai, openEO

DTE Infrastructure Modules
- interLink, Teapot, ALISE, FTS3, RUCIO, AI Based Orchestrator, APEL Accounting

<u>KER Champion:</u> EGI Foundation (Andrea Manzi)
<u>Target Groups:</u> Developers, Users, Operators
<u>IP Protection / IPR:</u> Copyright distributed under Free and Open Source Licence

Table 5 - KER1 Subcomponents. DTE Core Modules IPR & Access License

DTE Core Modules	Owner	License
OSCAR	UPV	Apache 2.0
dCNIOS (OSCAR+dCache)	UPV (+DESY)	Apache 2.0
PyOphidia	CMCC	GPLv3
yProv	UNITN	GPLv3
SQAaaS	UPV, LIP, CSIC/UNICAN	GPLv3
SQAaaS Github Actions	CSIC/UNICAN	GPLv3
SQAaaS CLI	CSIC/UNICAN, LIP	GPLv3
Infrastructure Manager	UPV	GPLv3

Configuration Artifacts	UPV	Apache2.0
Big Data Analytics TOSCA templates,	UPV	Apache 2.0
itwinai	CERN, FZJ	MIT
openEO	EURAC, EODC, WWU Munster	Apache 2.0

Table 6 - KER1 Subcomponents. DTE Infrastructure Modules IPR & Access License

DTE Infrastructure Modules	Owner	License
interLink	INFN	Apache 2.0
Teapot,	DESY	Apache 2.0
ALISE	KIT	MIT
FTS3,	CERN	Apache 2.0
RUCIO,	CERN	Apache 2.0
AI Based Orchestrator,	INFN	Apache 2.0
APEL Accounting	STFC UKRI	Apache 2.0

Table 7 - KER1 Subcomponents. DTE Thematic Modules IPR & Access License

DTE Physics Thematic Modules	Owner	License
openQxD	CSIC	GPLv2
normflow	ETHZ	MIT
PulsarDT PulsarDT++ PulsarRFI_Gen PulsarRFI_NN	MPIfR, HTW Berlin, PUNCH4NFDI UHEI	GNU AGPLv3
GlitchFlow	Ligo & Virgo Collaboration	GPLv3
3DGAN	CERN	MIT
DTE Environmental Thematic Modules	Owner	License
ML TC Detection	CMCC, UNITN	GPLv3
ML4Fires	CMCC	Apache 2.0
eddiesGNN	UNITN	GPLv3
xtclim	CERFACS	Apache 2.0

downscaleML	EURAC	GPLv3
CompEVPoEToE,	CNRS	CeCill-C
openeo-processes-dask, openeo-pg-parser-network,	EODC, EURAC	Apache 2.0
raster-to-stac,	EURAC	MIT
FloodAdapt,	Deltares	MIT
HydroMT-SFINCS,	Deltares	GPLv3
HydroMT-FIAT	Deltares	GPLv3
Hython Wflow_Svm Hydrological Model	Deltares	CC BY4.0

Development Progress:
- The initial reference architecture was described in the Architecture Design and Implementation Deliverables D5.1, D6.1, D7.1 and D7.2
- New set of Deliverables linked to 1st Release D7.3, D7.4, D5.2 and 6.2
- First Public DTE released end of February 2024
- Integration of DTE components into DT applications
- 1st version of applications in May 2024
- IP Management – All SW licenses spotted

Next Steps:
- Updated requirements & Second Release
- Exploitation Agreement

KER2: Interoperability Framework: Guidelines, Specifications, and Blueprint Architecture

Description: The interTwin interoperability framework aligns technical approaches and foster collaboration in modelling and simulation application development across scientific domains.
KER Champion: EGI Foundation (Raul Bardaji) + EURAC (Alexander Jacob)
Target Groups: Developers, Users, Operators
IP Protection / IPR: Creative Commons. CC BY 4.0

Table 8 - KER2 Subcomponents. IPR & Access License

Components / Subresults	Owner	License
D3.2	Project Partners - Collective work	CC BY 4.0
D3.3	Project Partners - Collective work	CC BY 4.0

Development Progress:

- First version of the DTE-blueprint architecture was published in D3.1, a second version was published in D3.4 and is expected to be followed up by a final version in D3.5
- Contributing to integration of interoperability – guidelines and best practices are being developed. Standardization work has been kick-started
- Feedback gathering from the EEAB, DestinE and other DT projects (DT-GEO, BioDT), and other initiatives such as DT Illiad, Data Spaces, etc, which are to be incorporated into the third version D3.5
- Interoperability Framework D3.3
- Joint work on a common glossary for DT and components.
- Contribution to Standardization from Digital Twin of the Earth

Next Steps:
- Intertwin general publication expected
- Update on DTE-blueprint architecture & Interoperability Deliverables (D3.5)

KER3: Toolkit for AI workflow and method lifecycle management

Description: AI-based methodologies to extract application sector-specific information from research data at the large scale level in a real-time manner and increase the efficiency and accuracy of simulation and modelling outputs.
KER Champion: FZJ (Mario Rutgers) / CERN (Alexander Zoechhauer, currently being replaced)
Target Groups: Developers, Users, Operators
IP Protection / IPR: Copyright, under Free and Open Source Licence

Table 9 - KER3 Subcomponents. IPR & Access License

Components	Owner	License
itwinai	CERN, FZJ	MIT

Development Progress:
- First release of modules released End of November 2023 D6.1 (AI Workflow architecture) and D6.2 (First release of the modules)
- Integration of CERN use case into AI workflow
- Integration of CMCC use case into AI workflow (Feb 2024)
- The AI workflow (itwinai) integrated with the other modules in WP6 and with the infrastructure layer (WP5) e.g. interLink is already done. use cases VIRGO, LatticeQCD, EURAC (Climate Drought)

Next Steps:
- Continue the integration with Use cases & other core & infrastructure modules

KER4: Quality Framework

Description: Tools for automated quality measures and trust, development of standard quality mapping and indicators for appropriately communicating differences in qualities

of inputs and outputs from digital twins, addressing issues such as data and model pedigree, accuracy, and service maturity (i.e. increased TRLs)

KER Champion: CSIC – Isabel Campos

Target Groups: Developers, Users
IP Protection / IPR: Free and Open Source Licence, Creative Commons

Table 10 - KER4 Subcomponents. IPR & Access License

Components	Owner	License
SQAaaS Platform	UPV, LIP, CSIC/UNICAN	GNU GPLv3.0
SQAaaS Github Action	CSIC	GNU GPLv3.0
SQAaaS CLI	CSIC/UNICAN / LIP	GNU GPLv3.0
JePL	CSIC	Apache 2.0
service-qa-baseline	CSIC	CC-BY-SA 4.0
FAIReva	CSIC	Apache 2.0
SQAaaS CLI	CSIC/UNICAN, LIP	GNU GPLv3.0

Development Progress:
- Quality framework developed under EOSC Synergy being extended for evaluating quality of DT use cases as explained in Task 3.3
- ItwinAI have been piloting the quality framework
- Evaluate developed DT to obtain the Quality Badge
- Milestone M6.2 - 30 of April – first pilot for definition capabilities of the quality framework
- Automatization via script SQAaaS GitHub actions

Next Steps:
- Continue evaluation of Use Cases within WP4, including Climate Change (Workflow documents, Python Scripts), Lattice QCD (python scripts)
- Service Definition
- Integration of Uncertainty Quantification work from WWU

KER5: DTE federated infrastructure integrated with EOSC and EU Data Spaces

Description: Federated distributed compute platform providing access to distributed data and integrating HTC, HPC, Cloud and Quantum Computing capabilities for processing.

KER Champion: INFN – Daniele Spiga – Diego Ciangottini

Target Groups: Users, Operators
Protection: Free and Open Source Licence

Table 11 - KER5 Subcomponents. IPR & Access License

Components	Owner	License
interLink	INFN	Apache 2.0
Teapot,	DESY	Apache 2.0
ALISE	KIT	MIT
FTS3,	CERN	Apache 2.0
RUCIO,	CERN	Apache 2.0
AI Based Orchestrator,	INFN	Apache 2.0
APEL Accounting	STFC UKRI	Apache 2.0

Development Progress:
- Main Services: interLink, CVMFS, Teapot, Rucio FTS, Indigo PaaS Orchestrator, APEL. All available
- Scientific community facilities including Cloud, HTC and HPC compute resources are being currently federated.
- Access to resources to all (EuroHPC Vega, Julich Cloud and HPC, UKRI Cloud, GRNET, KBCI, PSNC and EODC).
- Testbeds available: Compute: VEGA, Juelick, GRNET, KBFI, PSNC. Data: VEGA, PSNC. Pilot: VEGA, Juelich, EODC
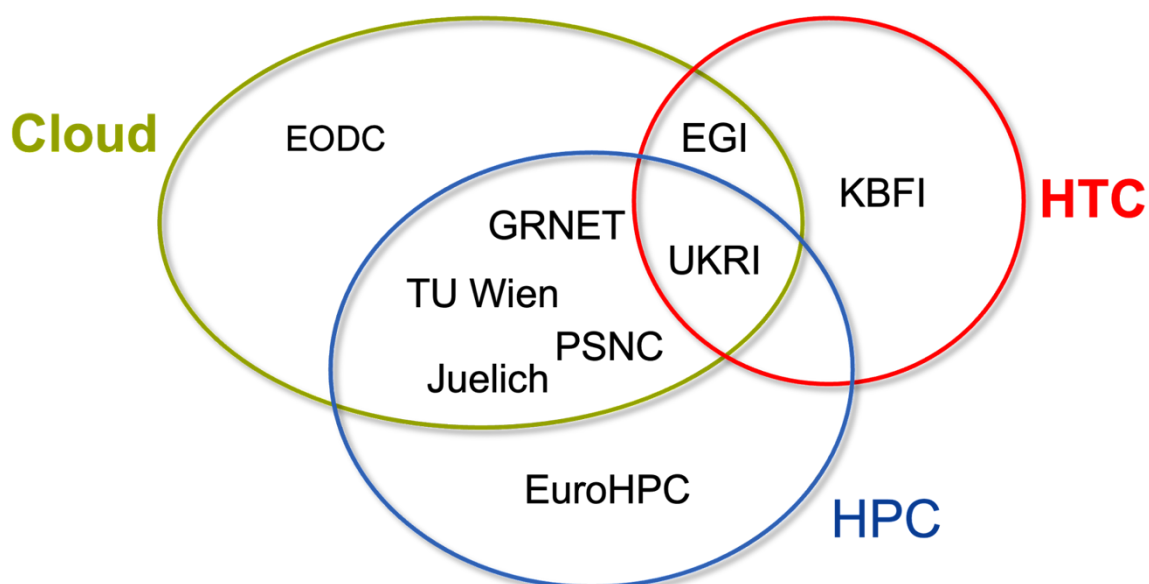

Figure 6 - infrastructure integration

Next Steps:
- Continue the integration of the test-beds & pilots across sites
- Work with compute & storage providers on sustainability
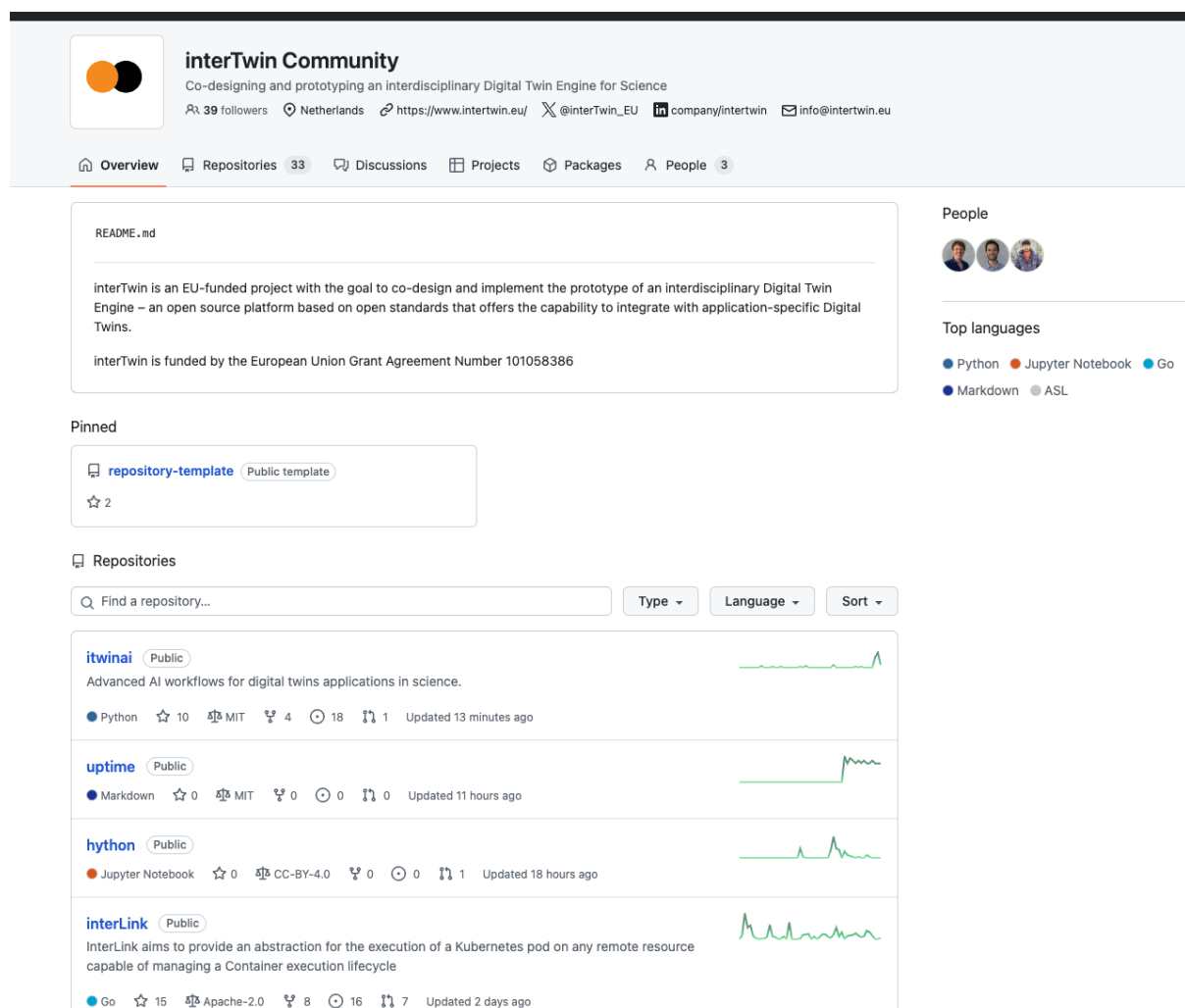
- Assess integration with EOSC & Data Spaces

KER6: interTwin Open-Source Community

Description: The community of DT application developers, users and operators that is responsible for the design, development, and maintenance of the DTE code base.
The KERs above will contribute to the realisation of interTwin expected outcomes and impacts.
KER Champion: EODC – Christian Briese / Charis Chatzikyriakou

Target Groups: Developers, Users, Operators
IP Protection / IPR: CC BY 4.0. Community Guidelines based on guidelines for OpenEO including handling of Repositories, Reviews, etc. Code of Conduct and Conflict

Figure 7 - interTwin Open Source Community

Development Progress:

- interTwin Github repository has been created and initial templates and guidelines described based in the quality framework

- Currently 33 Repos. 39 Followers

- Templates & GitHub Repository Management Rules created

Next Steps:

- Grow contributors across user communities
- Develop strategy for Open Source Community sustainability (for keeping community alive after the end of the project.

2.3 interTwin Exploitation Progress (M22)

D2.2. provided an expanded version of Exploitation and IP management plans. It includes provisions of ownership, gathering of results, specific provisions on software, business modelling workshops, results valorization, ensuring European sovereignty and involvement of SME and industry.

2.3.1 Innovation and Exploitation Group (IEG) Progress

The Innovation and Exploitation group (IEG) is the project board established to provide advice and support on the innovation management activities of the project.

- Drives implementation of the project's knowledge and protection strategy
- Collects and maintains the information related to project KERs as well as updating and monitoring dissemination and exploitation plan in line with the innovation management task (T2.1). This includes
  - o The management of IPR, access rights of project's background and foreground
  - o The maintenance of information related to dissemination and exploitation activities.
- Gives direction and facilitates discussion for capturing opportunities and developing initial technical concept candidates.

The Innovation and Exploitation Group is composed by the KER Champions, is chaired by the Innovation Manager and reports to the Technical Coordination Board. Members:

- KER1: Interdisciplinary Digital Twin Engine – Champion:
  - o EGI Foundation represented by Andrea Manzi
- KER2: Interoperability Framework: Guidelines, Specifications, and Blueprint Architecture – champion:
  - o EGI Foundation represented by Levente Farkas (till M12) and changed to EURAC after 1st Review, Alexander Jacob for the Standardization efforts and deputized by Raul Bardaji for the BluePrint Architecture efforts
- KER3: Toolkit for AI workflow and method lifecycle management – Champion:
  - o Initially EGI Foundation. Changed to CERN and FZJ after first review and was represented by Alexander Zoechbauer and Mario Ruetgers. At M24 CERN role

> is changing due to personnel change – KER Champion role has been proposed to Matteo Bunino as main representative of itwinai.

- KER4: Quality Framework – Champion:
  - CSIC, represented by Isabel Campos and Pablo Orviz.
- KER5: DTE federated infrastructure integrated with EOSC and EU Data Spaces – Champion:
  - INFN represented by Davide Salomoni (till M12) and changed to Daniele Spiga and Diego Ciangottini thereafter
- KER6: interTwin Open-Source Community – Champion:
  - EODC represented by Christian Briese and Charis Chatzikyriakou

During the first 6 months – the first IEG meeting was organized during the physical meeting in Madrid. In it the content of the Innovation Management System and the innovation management plan, including procedures and processes was presented and validated. It was useful to kick-start the work, to let KER champions understand their advisory role and to get relevant feedback to fine-tune the content for this Deliverable.

In the second period of the project (M6-12) the communications among the IEG Members was increased. In January 2024 2nd main meeting was organized to synchronize and update the Innovation Management Strategy in general and each of the KERs in particular. This meeting was followed by 1-on-1 interactions with KER Champions in order to update the plans of the KERs. During the F2F meeting in Vienna, the Business Model Training organized was tailored to trigger discussion among KER champions on the possible business models to foster the exploitation of the KERs.

2.3.2 Organization of Business Model Workshops and Webinars

In order to ensure all partners are well aligned, specific training on different aspects of business modelling, IP management and software licensing has been organized.

Business Model Planning Training Objectives

- Align partners with interTwin innovation management system
- Help partners along Intellectual Property Management matters
- Assess software licensing mechanisms
- Access to results
- Help to prepare the Exploitation plans & Exploitation Agreements needed
- Help to foster sustainability of project results and maximize impact of the project
- Expand Horizons & Learn new useful knowledge

For this several trainings, workshops and webinars have been planned and organized.
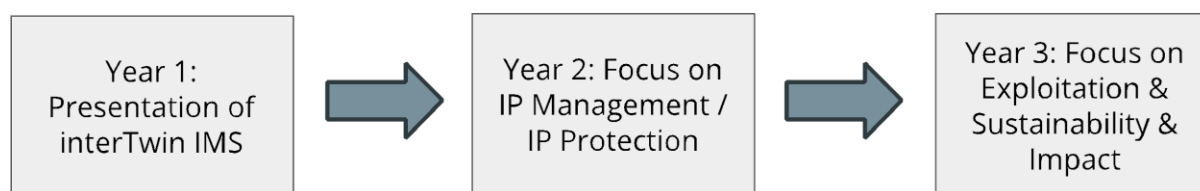
Figure 8 - interTwin Business Model Training Plan

During the first year, the main aim was to present interTwin partners the Innovation Management System so that they understand the framework created to comply with the Exploitation and IP management rules of the Grant Agreement. A webinar was held November 2023 and the milestone related to the Business Modeling Workshop was completed. It was a good opportunity to discuss with the partners on the future training needs on exploitation.

During the second year, the focus switched to enhance partners capabilities on IP Management and IP Protection. For this, several external experts in IP management, business modeling were presented. Across Legal was chosen, due to the adequacy of the training proposed to the needs of the project and the economic quotation. The main coach, Malcolm Bain, has delivered training for ASTP Proton[50] for many years and has extensive experience helping EC projects on their exploitation purposes. 3 Training sessions were planned.

- An online webinar to present the foundations for IP Management and open source software licensing to the project participants
- A hands-on physical workshop to discuss how those foundations are being applied to the project.
- A final public webinar to present the outcomes of the latter workshops to wider audiences

A specific webinar on patenting is also being considered, aimed at teaching partners about its opportunities (and challenges). The 3rd year it is expected to shift the focus of the Business Model Trainings to exploitation & impact delivery of the project. Annex 2 provides further information on the different trainings delivered so far.

2.3.3 Initial Business Model Analysis

One of the challenges of the project is to develop a proper business model or exploitation plan that ensures the sustainability of the project, taking into account the academic nature of many of the partners and initiatives and the open source.

In order to develop a proper Business Model it is necessary to work on where the value of open source relies. Many companies are building their businesses around open source software (OSS). Some are large software developers making hundreds of millions a year and are valued in the billions, such as MongoDB, elastic, databricks[51]. A study about the impact of open source software and hardware on technological independence,

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[50] https://www.astp4kt.eu/

[51] https://companiesmarketcap.com/

competitiveness and innovation in the EU economy [52] concluded that *the OSS pool contributes significantly to the EU's GDP, and that an increase of 10% in contributions would generate between 0.4% and 0.6% additional EU GDP per year. On a cumulative basis, the study estimates that, up to 2018, the contribution of OSS to EU GDP, and contributions of EU employees to OSS, yield a cost-benefit ratio of slightly above 1:10.* According to the study only 20% of ICT project costs are usually in licensing fees, while 80% of ICT project costs comes from other implementation costs, such as further development, consultancy/management, customization, integration, data migration, training and maintenance and support.

This also applies to interTwin. For each software component there are many different result types that can be valorized

- Software Code. Delivering it under Free and Open Source, gives access to anyone to use and re-use the code – with the limitations and provisions given in the specific SW licenses. They are perfect to increase the user bases and to promote the sharing of results between academics and comply with Open Science rules. Copyright is usually not enforced and large open source projects become collective work of many heterogeneous authors. On the other side Free and Open Source (FOSS) licenses imply software is delivered 'as is', without any warranty or liability and the commercial use even if not limited, needs to understand the limitations of the licenses to assess the adequacy of the projects.
- Know-How on the implementation. Much of the value of Open Source projects rely on the expertise that is generated around the technologies developed, being able to develop value added services, training, support or further code development. Consulting opportunities arise for Software Integration, customization or maintenance and user support
- Methodologies. Methodologies implemented by software code have the potential of being patented if they are novel and inventive, which can become a valuable IP asset.
- Data: Datasets needed, used and generated by the software code.
- Documentation: Software code can be complex and may be only usable if they are properly documented. Hence, it is a very important step for the creation of software products.
- Presentations, Training Material, Tutorials, Examples to complement the documentation and are also very important for user engagement.
- Branding related to the SW components can also become, such as logos and trademarks can be protected and become an IP Asset that can be valorized.

Therefore there is high valorisation potential for the project for the support services that can be generated from the software project, including the definition of Software as a Service (SaaS), user support service from experts -for the integration, customization or further development, maintenance and support and education and training.

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[52] https://op.europa.eu/en/publication-detail/-/publication/29effe73-2c2c-11ec-bd8e-01aa75ed71a1/language-en Blind, K.; Böhm, M., Grzegorzewska, P., Katz, A., Muto, S., Pätsch, S., Schubert, T. (2021).

Specifically within the interTwin project we consider the following approaches

- Open Science. "As Open As possible" (as closed as necessary)
- All Software components available as Open Source software Products
- Creation of Open Source Community supporting the software Products
- Creation of new services over the Software (such as Digital Twin Engine as a Service, Quality as a Service, SaaS)
- Standardization efforts & Interoperability and transfer to already Existing Services & Initiatives (EGI, DestinE, EOSC, etc)
- Follow up under research projects / Collaborative projects (e.g. Horizon Europe)
- Integration to already existing Open Source projects (Rucio, FTS, OpenEO)
- Policy Making
- Collaboration with SMEs / Industry

Valorisation of the results: As most of Open Source Software initiatives, the inherent value of the components relies on the know-how from project partners on how to develop, deploy and execute them. As such, complementary to Open Source distribution Software Products - main **exploitation path includes the creation of services over the Software** (such as Digital Twin Engine as a Service, Quality as a Service) which not only helps with the uptake of the results but also to secure funding to cover the maintenance, support, and sustainability of those. Those have been captured under Key Exploitable Results 1, 4 and 5 (see below the list of KERs). **Standardization** also plays an important role, not only by ensuring the results are well aligned with the current existing standards but also to try to create or influence them, being part of standardization working groups, etc. This is captured under Key Exploitable Result 2. Many **software products** will be created – not only as part of the Digital Twin Engine, but also linked to the specific core and thematic modules. Those have been captured under Key Exploitable Results 1 and 3 and will be made available under the Open Source Community on Key Exploitable Result 6, which will facilitate its uptake whether for **further research initiatives, or industrial adoption**.

Ensuring European Sovereignty: interTwin is a project aiming to facilitate grand-challenges for scientific developments - High-Energy Physics, Radio Astronomy, Astrophysics. Most of them are international research communities, where interTwin is contributing to ensure European efforts are meaningful for the overall international community. Environmental and Climate Change global challenges with a huge social impact for which Europe is aiming to be a pioneer. It is noteworthy to mention, use cases T4.6 and T4.7 also include regions of interest within and outside of Europe (e.g. Alpine region, Humber (UK), and Beira (Mozambique) in order to provide a variety of regions for the validation of the DT demonstrators -to validate their world-wide usage, and because of being (in the case of UK) - re-used within Destination Earth flagship initiative by the European Commission. Ownership of the IP generated by the use cases (i.e. DT software component, services, processed data and know-how) is thereby kept by the partner who has generated it -in line with Grant Agreement.

Industrial Engagement and SMEs: Whereas interTwin is a project targeting mainly scientific communities (to improve scientific infrastructures and the delivery of scientific results), the project aims to engage with industrial players and SMEs to assess the re-usability of the components and services on industrial domains. As such, it is foreseen to have dissemination and engagement activities at industrial events, include the participation of SME/industrial representatives' part of the External Expert Advisory Board and establish connection with industrial interest groups (such as EOSC Digital Innovation Hub). The establishment of an Open Source Community (KER6) will act as an enabler for the uptake of all components, as each of the partners will try to engage their internal and external stakeholders for that.

Following is the Progress at M22 for industrial engagement some interTwin components have already attracted some industrial attention, e.g. interLink and itwinai:

- Collaboration with an SME, Nunet AI has been started and some plug ins are under development. There are further collaborations under discussion with the objective to re-use interLink.
- Itwinai has already attracted the attention of large industrial players (e.g. was presented at NVIDIA GTC 2024 - Enabling Digital Twins for Science: A Perspective from CERN openlab") to the user community.

Presence at key events are starting to seek industrial collaborations:

- Teratec forum: Teratec is Large-scale event with 1000+ attendees (mostly francophone). We were part of the 'Village Europe' exposition, with a couple of other European projects (such as CEDAR and NEASQC). The other exhibitors included companies like Amazon, Hewlett Packard, NVIDIA, ... We had conversations showing our work on the DTE - there was quite some interest in the modularity of the DTE and the fact that it was open source. For example, we had a long conversation with EDF, a French 'green' energy company who was also working with digital twins to improve their work. https://www.forumteratec.com/en/content/nos-partenaires-2024
- WIthin ISC 2024, Maria Girone gave a presentation on interTwin to key representatives and Project poster was prepared and showed in the Exhibition
- TNC2024 attracted more than 800 visitors, mainly technical profiles. Our shared booth got visited quite a lot, and SPECTRUM/interTwin materials received attention. Notably, from technical exhibitors such as AWS and Google Cloud, but also from NRENs from outside of Europe (Uganda, South Africa). An interesting connection that was established with the 'Invest in Open Infrastructures' initiatives, we will follow up with EGI as organisation. https://investinopen.org/

2.3.4 KERs Exploitation Progress

The following is the Exploitation Progress for each of the KERs – in line with expected Exploitation Paths described in D2.2 and the definition of Exploitation the main common lines

"The use of results in further research and innovation activities other than those covered by the action concerned, including among other things, commercial exploitation such as developing, creating, manufacturing, and marketing a product or process, creating, and providing a service, or in standardisation activities.

The following Exploitation Paths are considered for all the components:

- **Further Research:** Assess new project opportunities for use/ reuse of results, including Cross collaboration with other DT-sister projects (DT-GEO, BioDT), Digital Twins of the Ocean, DestinE, or follow up project opportunities with project partners.
- **Product Creation:** SW sub-components available from interTwin repository, including proper Technical and User documentation and supported by Open Source community. Enhancement of already existing SW products
- **Service Creation:** Platform-as-a-Service provisioning by the EGI Federation through open access, Software as-a-Service of specific core components – such as the Quality Framework or the enhancement of already existing services – such as Infrastructure Manager, EGI Cloud or the creation of new services such as EGI HPC.
- **Standardization:** Alignment with standards and contribution to improving already existing standards (e.g. OGC) and the creation of new standards (e.g. IEEE standard for Digital Twin of the Earth)

At M22 exploitation is showing following progress:

- **Further Research:** Project has been re-using and further enhancing results from 4 previous projects (EOSC-Hub, EOSC-Enhance, CoE RAISE, C-SCALE). Currently there is active cross-project collaboration with 4 parallel projects and initiatives (DT-Geo, BioDT, DestinE, DT-Iliad/Digital Twins of the Ocean), and further collaborations are under discussion with 2 more (DECICE project and AI4EOSC) among many other collaborations (as described below and in D3.5). Several follow up project proposals including interTwin results have been presented and will be highlighted as success stories upon acceptance.
- **Product Creation:** 42 Software Components are available from the interTwin website and github repository - highlighting itwinai and interlink that have high potential for adoption and uptake as part of KER3 and KER5)
- **Service Creation:** 1 new service is being defined (KER1. DTE as a service to be included to the EGI Federation service catalogue). 2 services are being improved/enhanced (KER4: Quality Framework - SQAaaS and EGI Infrastructure Manager). interTwin knowhow is also contributing to the creation of a new service (EGI HPC)
- **Standardization:** Alignment with standards fully explained in the Interoperability guidelines (D3.3). In collaboration with DT-Illiad interTwin is collaborating to the creation of a new standard DT of the Earth.

The following are further detailed for each of the KERs:

Table 12 - KERs Exploitation Progress Tables

KER1: Interdisciplinary Digital Twin Engine
A software platform that provides generic and tailored functional modules for modelling and simulation to facilitate the development and deployment of Digital Twins that address scientific problems in different domains.
Exploitation Activities & Progress

Further Research

DTE subcomponents have been incorporated in other project proposals (in Horizon Europe, OSCARs Open Calls and other national initiatives). Any follow up projects granted will be included as success story granting the continuity of the component or group of components.

Product Creation

DTE as a product. i.e. SW components have been made available for use & reuse – from GitHub & as single components or subset of components. Technical and User documentation has been created for each of the components. Noteworthy to mention the DTE is not a monolithic component, instead follows a modular approach. As such different entry points for the developments / composing workflows are available depending on the needs of the DT. In the first release. 38 components have been made available.

Service Creation

During the project DTE service is prototyped by the deployment of the 10 DT use cases that are currently being integrated.

Working towards the definition of a DTE -as a service to be incorporated a an EGI service. (e.g. definition of SLA / OLAs with the providers and then follow the standard EGI procedure for Service Onboarding defined in the Integrated Management System. Process will start after the second release (upon more maturity of the services. Service is the composition of the components & modules and the support for customizing the DTs built with the DTE.

Standardization Activities

Alignment with current standards, as explained in the interoperability deliverable D3.3

Academic Use/ Education & Training

Webinar series have started on the technologies. Specific tutorials for some specific components. Also expected for the platform. They will be made available from interTwin website and GitHub

Technology Transfer / Licensing

Shared under Open Source licenses

KER2: Interoperability Framework: Guidelines, Specifications, and Blueprint Architecture

The interTwin interoperability framework aligns technical approaches and foster collaboration in modelling and simulation application development across scientific domains.

Exploitation Activities & Progress

Further Research / Collaborative Projects:

Collaboration with DT-Iliad and DT ocean and Cross-project collaboration with BioDT & DT-GEO and DestinE for the creation of a joint european glossary on digital twins

Standardization Activities:

Contribution to creating Working Group from IEEE for the Standardization of DT of the Earth, in collaboration with DT Iliad

Alignment with interoperability standards, e.g. CWL, or OGC contribution (as described D3.4) and specifically D3.7 interoperability with DestinE

Alignment with EOSC Interoperability Framework (as described D3.5) including EOSC core-services (AAI, Accounting, Monitoring, Helpdesk & Configuration Database), EOSC Compute Federation (Hybrid cloud orchestration, workload management & software distribution) and EOSC Exchange (e.g. Notebooks, PaaS Orchestrator, AI/ML Integration and Scalable Big Data Tools)

Technology Transfer/ Licensing:

Part of Interoperability assessment with DestinE it is expected overall knowhow several interTwin DTE components to be re-used under DestinE
Part of the Interoperability assessment with EOSC Service, it is expected overall know-how & interTwin DTE components to be re-used under EOSC or to further develop already existing EOSC services.

Open Science: All deliverables are made available open access via multiple channels such as interTwin managed web pages, EOSC and AI4EU ecosystems, and Zenodo. A scientific publication is expected describing the overall interTwin framework

KER3: Toolkit for AI workflow and method lifecycle management

AI-based methodologies to extract application sector-specific information from research data at the exabyte-scale level in a real-time manner and increase the efficiency and accuracy of simulation and modelling outputs

Exploitation Activities & Progress

Further Research / Collaborative Projects:

itwinai has been incorporated in other project proposals. Integration of itwinai with other core and infrastructure components will also facilitate the future collaboration between partners. Cross project collaboration with AI4EOSC - organizing a joint workshop expected for september 2024

Product Creation:

Available for download and maintained by the Open Source Community via repository technologies such as GitHub, already 2 forks of it. Technical and User documentation created. Specific branding being created including Logo and specific technical landing page. It is expected to be made available via multiple channels such as interTwin managed web pages, EOSC marketplace and AI4EU ecosystems

Technology Transfer/ Licensing :

itwinAI is part of the core-module building blocks of the Digital Twin Engine

Working to connect itwinAI the potential to use itwinai library with ECMWF to make it available for DestinE initiative.

Open science:

Expected publication for the integration of OSCAR + interLink + itwinAI. Many dissemination activities such as presentation at ACAT 2024 - also submitted to other conferences (PASC24, accepted to EuCAIFCon 2024). Progress of AI work has also been presented in major conferences with industrial presence – such as NVIDIA GTC or ISC 2024

KER4: Quality Framework

Tools for automated quality measures and trust, development of standard quality mapping and indicators for appropriately communicating differences in qualities of inputs and outputs from digital twins, addressing issues such as data and model pedigree, accuracy, and lack of knowledge.

Exploitation Activities & Progress

Further Research / Collaborative Projects:

The SQAaaS platform is a project outcome from the EOSC Synergy project which is being further developed in interTwin. It is a component that is also included in the cross-project collaborations with DT-GEO sister project, where the platform is used for the FAIR evaluation of project Data – whereas in interTwin it is used for the evaluation of the quality of the SW components.

Product Creation:

SW packages available from open repositories or downloaded and maintained by the Open Source Community via repository tech such as GitHub. Full documentation is available from GitHub repository and specific component website (https://sqaaas.eosc-synergy.eu/#/).There is specific branding and logo to maximize the dissemination of the component.

Service Creation:

Definition of a Quality Framework as a service (SQaaS) - deployment in production that includes automated QA assessment capabilities for: Source code, (web) Services and Data FAIRness that enables easy integration of new tools, testing frameworks, etc. to allow customized checks.

Technology Transfer/ Licensing :

SQAaaS is part of the core module building blocks of the Digital Twin Engine acting as of the QA module within the DTE architecture

Open science:

Open access available via multiple channels such as interTwin managed web pages, specific SQAaaS EOSC marketplace and AI4EU ecosystems, and Zenodo.

Scientific paper describing the component and its features: "Software Quality Assurance as a Service: Encompassing the quality assessment of software and services" (https://doi.org/10.1016/j.future.2024.03.024)

KER5: DTE federated infrastructure integrated with EOSC and EU Data Spaces

Federated distributed compute platform providing access to distributed data and integrating HTC, HPC, Cloud and Quantum Computing capabilities for processing.

Exploitation Activities & Progress

Service Creation:

Federated HPC infrastructure, know-how and technologies used for the creation of the EGI HPC service. Several meetings with Service Owner, and key infrastructure providers have been contacted (including Vega and EGI Federation members in interTwin offering HPC capabilities - such as GRNET) and University of Vilnius willing to offer their capabilities.

Maintained and managed as part of the EGI Service Catalogue offering policy-based access. (Policy-based: users are granted access based on policies defined by the EGI resource providers or by the EGI Foundation; such policies usually apply to resources being offered with "sponsored use" to meet some national or EU level objective, i.e., a country may offer resources with "sponsored use" to support national researchers involved in international collaborations.). Service ordering via EOSC Marketplace can't be done as Marketplace is being discontinued - as such the main entry point to be done under EGI. EGI is expecting to be formally established as an EOSC Node as part of contribution to EOSC federation (EGI Foundation. (2024). EGI Contribution to the EOSC Federation. Zenodo. https://doi.org/10.5281/zenodo.11128540)

Policy Making:

Policy Recommendations for federation of HPC resources compliant with EuroHPC Access Policies. Aim to collaborate with ETP4HPC WG on HPC Federation for the next Strategy Research Agenda.

Policy Recommendations for federation of HPC resources to be pushed to SPECTRUM project (Access Policies)

Product Creation:

interTwin Infrastructure modules available from main interTwin website: https://www.intertwin.eu/dte-infrastructure-modules/

SW component interLink being promoted as stand-alone product, ready for Use and Re-use: https://intertwin-eu.github.io/interLink/
Contacted by a Research Engineer from https://www.nunet.io/ as they are interested in further evaluating the interLink solution developed in T.5.1 in order to seamlessly federate word class HPC with Cloud. A first development for an interLink plugin has been done and tested on his side. There are 2 Technical Discussions he organized on this. Below the recorded version and in particular the second one is mostly on what he did with interLink (https://youtu.be/QZDforswEcQ?si=VCX_pdLkC025PA9c and https://www.youtube.com/watch?v=Adfg01-ECXk) and a follow up F2F meeting during the Kubecon conference in Paris.

Meeting with DECICE project (https://www.decice.eu/) planned for July 2024, as interested in interLink for their needs.

Technology Transfer/ Licensing :

KER5 are the infrastructure module building blocks of the Digital Twin Engine acting as the components that enable the data and compute federation of infrastructures necessary for the project implementation.

KER6: interTwin Open Source Community

The community of DT application developers, users and operators that is responsible for the design, development, and maintenance of the DTE code base.

Exploitation Activities & Progress

Community Creation
- Github repository his available and initial templates and guidelines for publication of the several released described based in the quality framework
- Community is free registration following approval processes guided by open science commons principles
- Currently the community is growing mainly from the project partners contributing to the different components. It is expected that the community grows across user communities as the Digital Twins use cases show results.
- In the next period a strategy for Open Source Community sustainability (e.g. Governance, Maintenance) will be developed including the creation of a steering committee / Rules of Participation to keep community alive after the end of the project are under discussion

At M22 use cases are considered the prototypes for testing the DTE and its components in some real-life environments. There have been discussions among the Innovation and Exploitation Group (IEG) and the project boards about the creation of a new KER that encompasses the Digital Twin use cases that have a high chance for being further exploited and deliver social impact.

3 Timeline, Next Steps and Conclusions

This deliverable has described the progress towards innovation management and its related activities at M22 including the Understanding the Market, Technological and Political Context, the results collection and IP management, and the progress toward project exploitation.
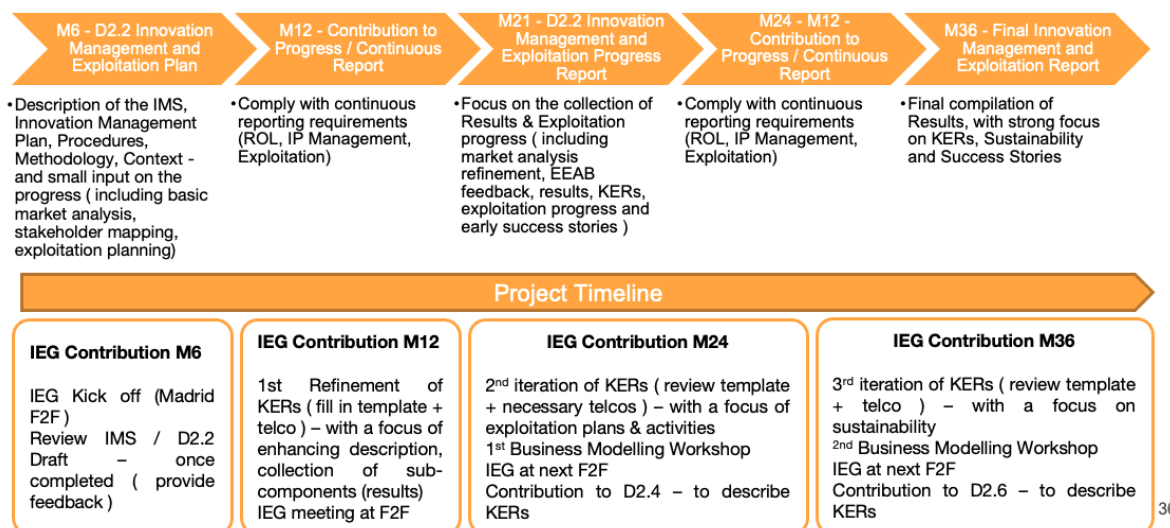
Figure 9 - Innovation Management Plan Timeline

- M6. The D2.2. Innovation Management and Exploitation Plan is outlined. Innovation and Exploitation Group is defined and constituted.
- M12. The 1st iteration of the collection of results, including ownership and IPR information, will be performed in order to contribute to the continuous reporting, and KERs will be refined.
- M22. This deliverable D2.4 includes an expanded market analysis, expected results, collection of EEAB feedback and progress towards exploitation, etc.
- M24. In order to capture and refine exploitation opportunities, the first Business Modelling workshop will be organized in order to upskill project partners and relevant stakeholders so the impact can be maximized. Updated data for the continuous reporting will be provided.
- M36. Final report adding on top of the previous progress D2.4 deliverable - with main focus on final results, exploitation activities and success stories, and the continued feedback of EEAB and other external stakeholders, the sustainability plan, etc.

Annexes

Annex 1: Detail of Stakeholder Mapping

Initiatives / Institutions	Type	Role	Market Domains	Relevance for interTwin	D&E Actions
Destination Earth (DestinE)	Public Initiative	User	Climate / Environmental Application Domain	ECMWF partner of interTwin, DT of Extremes (DOA) Relevant components (D3.1) :DestinE Digital Twin Engine (DestinE DTE) DestinE Data Lake (DEDL) DestinE Core Service Platform (DESP)	Planned piloting activities in the context of T3.2 and technological exchange (both ways) Technology exchange together with DT-Geo, BIoDT and EDITO-Infra (D3.1) Initial contact has been made with the C-SCALE, Fenix and Destination Earth (DestinE) for the Data Federation needs
EUMETSAT		Provider	Climate / Environmental Application Domain	Part of DestinE	Part of DestinE
ESA		User	Climate/Environmental Application Domain	Part of DestinE	Part of DestinE
EOSC	Public Initiative, Interest Group	User / Multiplier	Cloud Infrastructure Downstream Market	EOSC Portal onboarding of services (EOSC Exchange), EOSC IF (DoA)	Adhere to EOSC IF in some relevant areas (e.g. AAI), contribute to the EOSC

					IF by implementing guidelines for DTE The interTwin DTE will be onboarded in the EOSC Portal depending on the level of maturity reached at the end of the project, together with some of the DT applications. (D3.1) interTwin from one side will try to reuse some of the EOSC interoperability guidelines in order to be integrated with the EOSC Core and from the other will try to build new guidelines to be incorporated into the EOSC-IF
<u>EGI-ACE</u>	Project	Provider	Infrastructure Downstream Market	EOSC Computing platform / AAI	Extend the DTE infrastructure with providers coming from the EGI Federation and EOSC Computing platform, use EGI Check-in AAI (D3.1)
Escape	Project	Provider	Physics Application Domain	ESCAPE Data Lake Blueprint	Adoption of the ESCAPE data lake Blueprint and services in interTwin (D3.1)

					interTwin, apart from sharing some of the communities with ESCAPE (CERN and VIRGO), could benefit from the data lake architecture developed in the project, and named DIOS (D3.1). In particular the File transfer functionality is implemented by the FTS[53] service and the Data orchestration by the Rucio[54][2] service both developed at CERN.
C-SCALE	Project	Provider	Climate/Environmental Application Domain Infrastructure Downstream Market	Access of Copernicus data federation, possible technology exchange (openEO, EO-MQS based on STAC)	Understand from partners in interTwin part of the C-SCALE project (EODC, LIP, DELTARES, etc) the data access and technology contributions (D3.4) C-Scale components and services developed in the project which are relevant to the interTwin architecture blueprint are the FedEarthData, the EO-

					MQS and the openEO API. (D3.1) Understand if C-SCALE Workflows are able to be used or reused Initial contact has been made with the C-SCALE, Fenix and Destination Earth (DestinE) for the Data Federation needs (RP1)
openEO platform	Project	Provider	Climate/Environmental Application Domain	Implements data access and processing federation based on openEO API and common process-graph definition.	Understand from partners in interTwin part of the openEO platform project (EODC, EURAC, WWU, TU Vienna) the data access and technology
DigitalTwin Consortium	Interest Group	Multiplier, Standardizatio n Body	Digital Twins	Definitions and Digital Twin glossaries (https://www.digitaltwinc onsortium.org/glossary/) , Working group on Digital Twins for Research and Academia: https://www.digitaltwinc onsortium.org/working-groups/academia-research/	Mapping of the concepts, such us the Digital Twin systems into the next version of the Blueprint architecture (DoA). Definition (D3.4)

GAIA-X	Public Initiative / Interest Group	Provider, Multiplier	Cloud Infrastructure Downstream Market Data Horizontal	Cloud and Sovereign data federation in Europe.	Participation to technical WGs and architecture alignment (DoA) The activity of Gaia-X is also driven by WGs where members of the Gaia-X ASBL can participate and contribute to. For instance, both EGI Foundation and INFN as Gaia-X members are contributing to Architecture and AAI WG. (D3.4)
EU Data Spaces and SIMPL	Public Initiative	Provider	Data Horizontal	Access to Sectoral Data space data via integration of the SIMPL framework	Analysis of the first version of the SIMPL MVP in 2024 interTwin integration with SIMPL will be evaluated as the first MVP implementation will be delivered, in particular to understand the type of data which could be made available for interTwin DTE and use cases. (D3.4)
TECH-01-2021 Projects - DT-Geo	Projects	User	Digital Twins Climate/Environmental Application Domain	Projects funded in the same call (TECH-01-2021 Projects) as interTwin	Analysis of architectures and synergies to be put in place also thanks to DG-Connect driven initiative.

					DT-Geo, BIoDT and interTwin organizing monthly meetings MoU - Collaboration Agreement being prepared Participation in Joint Activities & Events - EOSC Symposium 2023 and 2024, etc Participation in Joint Position Paper - White paper on interTwin Members of interTwin EEAB
TECH-01-2021 Projects - BioDT	Projects	User	Digital Twins Climate/Environmental Application Domain	Projects funded in the same call (TECH-01-2021 Projects) as interTwin	Analysis of architectures and synergies to be put in place also thanks to DG-Connect driven initiative. DT-Geo, BIoDT and interTwin organizing monthly meetings MoU - Collaboration Agreement being prepared Participation in Joint Activities & Events - EOSC Symposium 2023, etc Participation in Joint Position Paper - White paper on interTwin Members of interTwin EEAB

Climate related EuroHPC projects eflows4HPC, Cheese CoE	Project	User	Climate / Environmental Application Domain HPC Infrastructure Downstream Market	EuroHPC Projects in the DT-Geo roadmap	T4.5 Paper -Climate Change Future Projection of Extreme Events *G. Accarino, D. Donno, F. Immorlano, D. Elia, G. Aloisio (2023). An Ensemble Machine Learning Approach for Tropical Cyclone Localization and Tracking from ERA5 Reanalysis Data. Earth and Space Science. https://doi.org/10.1029/2023 EA003106*
In relation to climate and weather modelling, the EuroHPC Joint Undertaking is managing some prominent R&I projects including: ☼ ESiWACE3 (Center of Excellence for weather and climate - phase 3) ☼ MAELSTROM (MAchinE Learning for Scalable meTeoROlogy and climate)	Projects	User / Provider ?	Digital Twins HPC Infrastructure Downstream Market	EuroHPC Projects related to Climate & Weather phenomena.	Assess potential interaction

☼ HiDALGO2 Project CoE (HPC and Big Data Technologies for Global Challenges) which simulates violent weather phenomena.					
COE Raise	Project	Provider	AI Horizontal	AI technologies and knowledge CERN-related LHC Use Case: https://www.coe-raise.eu/event-reconstruction	RAISE presentation at Kick off meeting AI Tools & Technologies to be reused for interTwin
Other DT Projects: CogniTwin : COGNITWIN - Cognitive plants through proactive self-learning hybrid digital twins Manufacturing domain: Circular TwAIN project HORIZON-CL4-2021-TWIN-TRANSITION-01-07: Artificial Intelligence for	Projects	User / Provider?	Digital Twins in other application domains	Development of Digital Twins within other domains (manufacturing, industry 4.0, etc) Mapping of DT-Related standards	

sustainable, agile manufacturing AgriFood domain: DEMETER project <u>DIGITbrain</u> is an EU innovation program which has the vision to unleash manufacturers' innovation potential through Digital Twins.					
ENES, members of the earth observation community active in GEO (Group on Earth Observation) and EARSeL (European Association of Remote Sensing Laboratories).	Research Infrastructure / Interest Groups	Providers / Multipliers	Climate/Environmental Application Domain	Datasets to be used	
<u>HL-LHC</u>	Research Infrastructure	Providers / Users	Physics Application Domain	DT aimed to improve the HL-LHC infrastructure	<u>WP4.1 Lattice QCD Simulations - High Energy Physics</u> <u>WP4.2 Detector simulation - High Energy Physics</u>
<u>PANGEO</u>	Research Infrastructure	Providers / Users	Climate/Environmental Application Domain		

Einstein Telescope (ET)	Research Infrastructure	Providers / Users	Physics Application Domain	Use Case	WP4.4 VIRGO Noise detector DT - Astrophysics
VIRGO	Research Infrastructure	Providers / Users	Physics Application Domain	Use Case	WP4.4 VIRGO Noise detector DT - Astrophysics
ENVRI	Research Infrastructure / Interest Groups	Providers / Users	Climate/Environmental Application Domain	Data & Tools can be used Access to community Synergies with ENVRI-HUB	EEAB Feedback
Related Projects: ENVRI-FAIR / ENVRI-HUB-NEXT	Project	Providers / Users	Climate/Environmental Application Domain	Marketplace for Services, Data, Knowledge and use cases https://envri-hub.envri.eu/	ENVRI-Hub-Next is coordinated by EGI
IRISCC	Project	Providers / Users	Climate/Environmental Application Domain	Marketplace for Services, Data, Knowledge and use cases related to climate	Innovation management coordinated by EGI
FENIX	Project / eInfrastructure	Providers / Users	Infrastructure Downstream Market	Openstack & Infrastructure manager has been integrated in FENIX part of DT-GEO so it could potentially open opportunities to run interTwin on FENIX	Use or re-use Fenix infrastructure & data Understand federation strategy of Fenix Initial contact has been made with the C-SCALE, Fenix and Destination Earth (DestinE) for the Data Federation needs
ETP4HPC	Interest Group	Providers / Multiplier	HPC Infrastructure Downstream Market	DestinE Roadmapping Discussions (https://www.etp4hpc.eu	

				/strategic-technology-agenda-for-destine.html)	
EuroHPC	Public / Private Partnership	Funding	HPC Infrastructure Downstream Market	interTwin aims to federate EuroHPC facilities (e.g. Vega) Collaborations with EuroHPC funded projects interTwin aims to test federation of Quantum facilities	
TEMA	Project	User (Public Administratio n)	Climate/Environmental End Users	Adoption of Climate Related DTs	Participation at Joint Events
AI4EUROPE / AI-on-Demand	Project	Multiplier	AI Horizontal	Channel for dissemination and exploitation AI-related results (e.g. KER3, itwinAI, etc) AI-Assets: https://www.ai4europe.eu/contribute/ai-asset (https://www.ai4europe.eu/research/ai-catalog) Projects: https://www.ai4europe.eu/contribute/project (https://www.ai4europe.e	Contribute to https://www.ai4europe.eu/contribute

				u/ai-community/projects) Education & Training https://www.ai4europe.eu/contribute/education (https://www.ai4europe.eu/education/education-catalog)	
iMagine	Project	Provider / User	Climate/Environmental Application Domain		Meeting to understand synergies
HiPEAC	Project / Community	Multiplier	Infrastructure Downstream Market	Dissemination channel (e.g. events, web, news, newsletter) HiPEAC Conference: https://www.hipeac.net/2024/munich/#/ Webinar: https://www.hipeac.net/webinars/#/ HiPEAC Magazine: https://www.hipeac.net/news/#/magazine/ HiPEAC Vision: https://www.hipeac.net/vision/#/latest/ Projects: https://www.hipeac.net/network/#/projects/	Start using HiPEAC network to showcase interTwin

Digital Twins of the Ocean - DT-Iliad	Project	Provider / User	Digital Twins Climate/Environmental Application Domain Infrastructure Downstream Market	Developing Digital Twins of the Ocean - leveraging Data, Infrastructures (Cloud, HPC, etc)	Dissemination & Exploitation responsible - BlueLobster - to be part of the EEAB
Digital Twins of the Ocean - Aquainfra	Project	Provider / User	Digital Twins Climate/Environmental Application Domain Infrastructure Downstream Market	Interoperability with EOSC. Working with the Digital Twins of the Oceans	Dissemination & Exploitation responsible - BlueLobster - to be part of the EEAB
Digital Twins of the Ocean: EDITO-Infra	Project	Provider / User	Digital Twins Climate/Environmental Application Domain Infrastructure Downstream Market	Potential Data-Providers. Validation of Reference Architectures / DTE / Interoperability / Co-Creation of DTs - use cases	
Digital Twins of the Ocean - EDITO-ModelLab:	Project	Provider / User	Digital Twins Climate/Environmental Application Domain Infrastructure Downstream Market	Alignment with DestinE needed	Participation in the Joint sessions of ECMWF and DT-GEO, BioDT.
BlueLobster	Company / SME	Multiplier	Climate/Environmental Application Domain	Partners in DT of the Ocean Projects AquaInfra & Iliad	Contact established at EOSC Symposium 2023 Simon Keeble contacted for EEAB Marketplace of Ocean-Related DigitalTwins -

					channel for publishing any interTwin related output
SPECTRUM	Project	User / Multiplier	Physics Application Domain	Roadmapping for HEP	Provide use cases
DECICE	Project	User	Infrastructure	Interest on interLink	Meetings to assess collaboration opportunities
AI4EOSC	Project	User/Multiplier	AIHorizontal	Interest on itwinai	Meetings to assess collaboration opportunities

Annex 2: Business Model Webinars

1st Internal Business Model Webinar - the interTwin Innovation Management System

Short Description:

- Motivation & Context: interTwin project advancing. First version of interTwin Blueprint architecture was presented along the first set of technical deliverables covering user requirements and technological choices and expected architecture and developments for interTwin solutions. Innovation Management processes have been set up and early expected results spotted. As the first project review is approaching - it is time to gear up the exploitation to not only understand the technologies under development but the opportunities for their use and re-use after the end of the project.

- Purpose: This webinar aims to refresh interTwin partners on the innovation management processes established within project, providing examples on how project is addressing the collection of Results, Key Exploitable Results and emerging Innovations, and how it is expected to work on the exploitation and sustainability plans related to them.

Target Audience: Project Partners aiming to ensure that the results are duly captured and exploited.

Channel: Webinar - to be recorded

Access: Limited to project partners & video recording accessible to partners

Date: 23 November 2023

Announcement: "The interTwin project is advancing! The first version of interTwin Blueprint architecture was presented along the first set of technical deliverables covering user requirements and technological choices and expected architecture and developments for interTwin solutions. Innovation Management processes have been set up and early expected results are emerging. As the first project review is approaching - it is time to gear up the exploitation to not only understand the technologies under development, but also to identify the opportunities for their use and re-use after the end of the project."

2nd Internal Business Model Webinar - Introduction to IPR and SW Open source licensing (Malcolm Bain)

Short Description:

- Motivation & Context: interTwin project is currently at the middle of the project. First release of the SW components has recently been published and have been

made available under the interTwin community GitHub and early feedback is being collected to incorporate it at the second release. As they are part of the Digital Twin Engine, it is important to assess under which conditions access will be made available. Part of intellectual property (IP) interTwin strategy is to deliver all project outputs following open science principles as stated in the Grant Agreement, and as such, SW components are expected to be distributed under open source licenses (and hence under the copyright stated in each license)

- Purpose: This webinar aims to refresh interTwin partners on the fundamental concepts of legal protection of R&D results, including Intellectual Property (Copyright, Databases), and Industrial property (patents, trademarks, trade secrets, etc), Software Licensing and Business Models.

Learning Objectives

- Participants understand the core concepts of software and data licensing
- Participants understand scope and implications of Open Science and Open Source licensing
- Participants have awareness of software and data based business models (particularly in science context).
- Participants understand the link between open source and business and technology exploitation opportunities

Activities:

- Presentation of software and data licensing basics
- Presentation of software and data driven innovation and business models. Interactive case based discussion
- Discussion of licensing exploitation options and open science

Target Audience: IEG-KER Champions, SW component owners and Project Partners aiming to ensure that the components are properly licensed.

Channel: Webinar - to be recorded

Access: Limited to project partners & related projects. Video recording accessible to partners

Date: 30 May 2024 - 11.00-12.30

Announcement: "interTwin project is currently at the middle of the project. First release of the SW components has recently been published and have been made available under the interTwin community GitHub and early feedback is being collected to incorporate it at the second release. As they are part of the Digital Twin Engine, it is important to assess under which conditions access will be made available. Part of intellectual property (IP) interTwin strategy is to deliver all project outputs following open science principles as stated in the Grant Agreement, and as such, SW components are expected to be distributed under open source licenses (and hence under the copyright stated in each

license). This webinar aims to refresh interTwin partners on the fundamental concepts of legal protection of R&D results, including Intellectual Property (Copyright, Databases), and Industrial property (patents, trademarks, trade secrets, etc), Software Licensing and Business Models."

3nd Business Model Workshop - F2F Hands-on-session on SW Open source licensing (Across Limits)

Short Description:

- Motivation & Context: interTwin project is currently at the middle of the project. First release of the SW components has recently been published and have been made available under the interTwin community GitHub and early feedback is being collected to incorporate it at the second release. As they are part of the Digital Twin Engine, it is important to assess under which conditions access will be made available. Part of intellectual property (IP) interTwin strategy is to deliver all project outputs following open science principles as stated in the Grant Agreement, and as such, SW components are expected to be distributed under open source licenses (and hence under the copyright stated in each license)
- Purpose: This F2F workshop aims to expand on the theoretical foundations explained in the webinar, refresh interTwin partners on the fundamental concepts of legal protection of R&D results, including including Intellectual Property (Copyright, Databases), and Industrial property (patents, trademarks, trade secrets, etc), Software Licensing and Business Models.

Learning Objectives

- Participants apply the core concepts of software and data licensing to SW components to the specific components developed in the project
- Participants discuss how Open Source licensing choices align with Open Science, business models and their further valorisation & use (exploitation)

Activities:

- Go through the project related SW components & modules and discuss about the implications or the license choices
- Discussion of business models & licensing exploitation options and open science for interTwin SW components

Target Audience: IEG-KER Champions, SW component owners and Project Partners aiming to ensure that the components are properly licensed.

Channel: F2F & Online for those who cannot attend

Access: Limited to project partners & related projects. Video recording accessible to partners

Date: 13 June 2024 - 11.15 - 13.5

Announcement: "interTwin project is currently at the middle of the project. First release of the SW components has recently been published and have been made available under

the interTwin community GitHub and early feedback is being collected to incorporate it at the second release. As they are part of the Digital Twin Engine, it is important to assess under which conditions access will be made available. Part of the intellectual property (IP) interTwin strategy is to deliver all project outputs following open science principles as stated in the Grant Agreement, and as such, SW components are expected to be distributed under open source licenses (and hence under the copyright stated in each license). This F2F workshop aims to expand on the theoretical foundations explained in the webinar by presenting some examples from the interTwin project.

Annex 3: Technology Watch tracked news

Title	Tags	Created	
Read the State of Open Infrastructure 2024 Report	OpenInfrastructure	2024-06-11T01:38:09.775Z	https://www.rd-alliance.org/news/read-the-state-of-open-infrastructure-2024-report/
Research Infrastructures for Planetary Boundaries	ResearchInfrastructure, ICoS, Landscape	2024-06-11T00:01:27.002Z	https://www.linkedin.com/pulse/research-infrastructures-planetary-boundaries-werner-leo-kutsch-jvjgf
The state of AI in early 2024: Gen AI adoption spikes and starts to generate value	AI, Market	2024-06-05T15:46:24.182Z	https://www.mckinsey.com/capabilities/quantumblack/our-insights/the-state-of-ai?stcr=D65B59511D5A4090A48ACEA19F2A2068&cid=other-eml-alt-mip-mck&hlkid=663b07a2cb3546e4a8a439ebd78d5ef0&hctky=14824372&hdpid=4e5b39a9-b017-49dc-bc7c-df8a492b551a
Landscape2024	ESFRI, Landscape	2024-06-05T08:11:30.642Z	https://landscape2024.esfri.eu/
Feature Article: FloodAdapt Will Help Protect Flood-prone Communities | Homeland Security	FloodAdapt	2024-05-31T22:20:46.924Z	https://www.dhs.gov/science-and-technology/news/2024/05/30/feature-article-floodadapt-will-help-protect-flood-prone-communities
Commission establishes AI Office	AI	2024-05-30T09:57:25.618Z	https://ec.europa.eu/commission/presscorner/detail/en/IP_24_2982

Digital Twins | Deltares	Deltares, DigitalTwins	2024-05-28T11:44:37.285Z	https://www.deltares.nl/en/expertise/projects/digital-twins
Brochure of Use Cases on EOSC and Open Science	EOSC, OpenScience, InfrastructureManager, SQAaaS, FAIREva, OSCAR	2024-05-27T12:11:04.676Z	https://zenodo.org/records/10822698
AI: Council reaches political agreement on the use of super-computing for AI development	AI, EuroHPC	2024-05-27T11:24:29.571Z	https://www.consilium.europa.eu/en/press/press-releases/2024/05/23/ai-council-reaches-political-agreement-on-the-use-of-super-computing-for-ai-development/
A competitive and resilient Europe requires transitioning from sectoral to systemic thinking		2024-05-23T14:41:30.846Z	https://www.euractiv.com/section/economy-jobs/opinion/a-competitive-and-resilient-europe-requires-transitioning-from-sectoral-to-systemic-thinking/
(2) Feed | LinkedIn		2024-05-23T14:40:52.365Z	https://www.linkedin.com/feed/
Artificial intelligence (AI) act: Council gives final green light to the first worldwide rules on AI - Consilium	AI, AI-Act	2024-05-21T23:30:38.791Z	https://www.consilium.europa.eu/en/press/press-releases/2024/05/21/artificial-intelligence-ai-act-council-gives-final-green-light-to-the-first-worldwide-rules-on-ai/
Digital Twins | Deltares	DigitalTwins, Deltares	2024-05-21T20:16:07.836Z	https://www.deltares.nl/en/expertise/international/europe/digital-twins
A New EuroHPC JU Advisory Group Officially Established - European Commission	EuroHPC	2024-05-19T00:05:38.019Z	https://eurohpc-ju.europa.eu/new-eurohpc-ju-advisory-group-officially-established-2024-05-02_en

264 proposals submitted to the 1st OSCARS Open Call | OSCARS	OSCARs	2024-05-17T18:33:53.515Z	**https://oscars-project.eu/news/264-proposals-submitted-1st-oscars-open-call**
Alexander Zöchbauer - Forbes	CERN	2024-05-15T00:29:16.209Z	**https://www.forbes.at/artikel/alexander-zoechbauer.html**
SUPERCOMPUTERS:DECODING THE SCIENCE	DestinationEarth, HPC	2024-05-11T12:30:56.109Z	**https://stories.ecmwf.int/supercomputers/index.html**
Understanding DestinE's	DestinationEarth, DigitalTwins	2024-05-11T12:29:12.485Z	**https://stories.ecmwf.int/explainer-digitaltwins/index.html**
THE DIGITAL TWIN ENGINE	DestinationEarth, DigitalTwins, DTE	2024-05-11T12:28:04.567Z	**https://stories.ecmwf.int/the-digital-twin-engine/**
Climate Change Adaptation Digital Twin: a window to the future of our Planet	DestinationEarth, Climate, ClimateDT	2024-05-11T12:24:27.330Z	**https://stories.ecmwf.int/climate-change-adaptation-digital-twin-a-window-to-the-future-of-our-planet/index.html**
Study about the impact of open source software and hardware on technological independence, competitiveness and innovation in the EU economy | Shaping Europe's digital future	OpenSource, OSH, Impact, EuropeanComission	2021-09-06T14:41:25.588Z	**https://digital-strategy.ec.europa.eu/en/library/study-about-impact-open-source-software-and-hardware-technological-independence-competitiveness-and**
BSC, a key player in the development of a digital twin to simulate future impacts of climate change on Earth | BSC-CNS	DigitalTwins, DestinationEarth, BSC	2024-05-11T09:26:44.664Z	**https://www.bsc.es/news/bsc-news/bsc-key-player-the-development-digital-twin-simulate-future-impacts-climate-change-earth**

Edge IoT Industrial Immersive Technologies and Spatial Computing Continuum, Release 1 – AIOTI	AI, IoT, Edge	2024-05-08T21:31:50.093Z	https://aioti.eu/edge-iot-industrial-immersive-technologies-and-spatial-computing-continuum-release-1/
The fast development of DestinE's Climate Change Adaptation Digital Twin - Destination EarthDestination Earth	DestinationEarth, ECMWF	2024-05-06T22:51:31.933Z	https://destine.ecmwf.int/news/the-fast-development-of-destines-climate-change-adaptation-digital-twin/
Destination Earth - Redefining the Next Era of Adaptation Decision-Making en Vimeo	DestinationEarth, AdaptationEarth	2024-05-03T15:14:38.419Z	https://vimeo.com/939069924
European State of the Climate 2023 | Copernicus	Copernicus, Climate	2024-05-03T00:50:42.459Z	https://climate.copernicus.eu/esotc/2023
A Marketplace for digital twins and models of the ocean with user feedback services - YouTube	DigitalTwins, DT-Oceans, DT-Iliad	2024-05-02T14:16:02.228Z	https://www.youtube.com/watch?v=gbViOjaLQpc
Digital twins: When and why to use one	DigitalTwins	2024-05-02T11:43:52.226Z	https://www.mckinsey.com/capabilities/mckinsey-digital/our-insights/tech-forward/digital-twins-when-and-why-to-use-one
Optimizing high-performance Computing simulation processes	eflows4hpc	2024-04-18T21:43:23.127Z	https://eflows4hpc.eu/wp-content/uploads/2024/04/Data.pdf
Destination Earth goes live! | Shaping Europe's digital future	DestinE, DestinationEarth	2024-04-18T21:40:53.737Z	https://digital-strategy.ec.europa.eu/en/events/destination-earth-goes-live
EOSC-A signs Barcelona Declaration on Open Research Information - EOSC Association	open science	2024-04-16T20:15:58.517Z	https://eosc.eu/news/2024/04/eosc-a-signs-barcelona-declaration-on-open-research-information/

CNCF Research User Group: Kubernetes HPC + SLURM Integration (April 3, 2...	kubernetes, HPC	2024-04-14T16:19:42.543Z	https://youtube.com/watch?v=7MTb8iyvG5Q&si=bRlUR6rxlS_WI8Mf
Digital twin of the earth helps firms assess climate risk - TechHQ	climate-x	2024-03-28T18:31:02.694Z	https://techhq.com/2023/03/digital-twin-of-the-earth-helps-firms-assess-climate-risk/
Digital Twin Global Market Report 2024 - Research and Markets	market	2024-03-28T18:24:11.357Z	https://www.researchandmarkets.com/reports/5939231/digital-twin-global-market-report#rela4-4787530
Digital Twin - Market Share Analysis, Industry Trends & Statistics, Growth Forecasts 2019 - 2029	market, DigitalTwins	2024-03-28T18:21:53.558Z	https://www.researchandmarkets.com/reports/4787530/digital-twin-market-share-analysis-industry
Global Digital Twin Market Growth Drivers, Size, Industry Forecast to 2028	market	2024-03-28T18:19:21.281Z	https://www.globenewswire.com/en/news-release/2024/01/25/2816781/0/en/Global-Digital-Twin-Market-Growth-Drivers-Size-Industry-Forecast-to-2028.html
What Is a Digital Twin? | IBM	IBM	2024-03-28T18:12:04.373Z	https://www.ibm.com/topics/what-is-a-digital-twin
Digital Ecosystems for Developing Digital Twins of the Earth: The Destination Earth Case	DestinE, DestinationEarth	2024-03-28T18:03:33.152Z	https://www.mdpi.com/2072-4292/13/11/2119
How Will Digital Twins Evolve in the Future? Predictions and Emerging Trends	Market	2024-03-28T17:42:00.463Z	https://insights.daffodilsw.com/blog/the-future-of-digital-twins
Potential of Digital Twins - Bridge Between Physical and Digital World	Market, AWS, Azure, GoogleCloud, DigitalTwins	2024-03-28T17:39:20.456Z	https://harshvardhan.blog/digital-twin-application-cloud-services

Destination Earth – A digital twin in support of climate services	DigitalTwins, DestinationEarth	2024-03-28T17:35:27.343Z	https://www.sciencedirect.com/science/article/pii/S2405880723000559
Future digital twins final2	market, DigitalTwins	2024-03-28T17:31:11.908Z	https://digitalreality.ieee.org/images/files/pdf/Future_Digital_Twins-FINAL2.pdf
Council Post: Digital Twins: Where To Next?	market	2024-03-28T17:13:22.522Z	https://www.forbes.com/sites/forbestechcouncil/2023/07/11/digital-twins-where-to-next/
Beyond forecasting: Machine Learning exploring climate impacts - Foresight	CMCC, ML, Climate, AI	2024-03-28T16:50:54.529Z	https://www.climateforesight.eu/articles/beyond-forecasting-machine-learning-exploring-climate-impacts/
The role of computational science in digital twins	DigitalTwins, ScientificChallenges	2024-03-27T17:47:58.149Z	https://www.nature.com/articles/s43588-024-00609-4
The rise of digital twins	DigitalTwins	2024-03-27T12:11:23.907Z	https://www.nature.com/collections/feicjiideh
This 'digital twin' of the planet could rival Google Earth — here's how you can try it	DigitalTwins, AI, Copernicus, GoogleEarth	2024-03-20T09:37:27.772Z	https://thenextweb.com/news/digital-twin-rival-google-earth-nimbo
The global costs of extreme weather that are attributable to climate change	ExtremeWeather, ClimateChange, impact, SocioeconomicImpact	2024-03-20T09:14:18.696Z	https://www.nature.com/articles/s41467-023-41888-1
NVIDIA Announces Earth Climate Digital Twin	Nvidia, DigitalTwins, AI	2024-03-20T09:08:03.624Z	https://nvidianews.nvidia.com/news/nvidia-announces-earth-climate-digital-twin

Software quality assurance as a service: Encompassing the quality assessment of software and services - ScienceDirect	Quality, SQAaaS	2024-03-13T10:50:43.635Z	**https://www.sciencedirect.com/science/article/pii/S0167739X24000955**
Get ready for Machine Learning on Civo GPU Nodes... from your Minikube!	interLink, kubernetes	2024-03-11T15:33:55.354Z	**https://youtube.com/watch?v=zhIrsMqPiOg&si=Pvg2gURyQa8dmqDG**
Eviden leads consortium to provide "Simpl-Open" OSS Data Spaces Middleware to the European Commission | Eviden	SIMPL, Eviden	2024-03-09T09:57:42.877Z	**https://eviden.com/insights/news/eviden-leads-consortium-to-provide-simpl-open-oss-data-spaces-middleware-to-the-european-commission/**
European AI Office | Shaping Europe's digital future	AI, AI-Act, AI-Office	2024-03-02T02:19:00.037Z	**https://digital-strategy.ec.europa.eu/en/policies/ai-office**
The Launch of the European AI Office: A Game-Changer for AI Governance and Cooperation	AI	2024-02-24T22:01:13.606Z	**https://www.linkedin.com/pulse/launch-european-ai-office-game-changer-governance-cooperation-4mdye**
BDVA - Big Data Value Association on LinkedIn: 🔔 BDVA is glad to announce the publication of its position paper on "Data...	data spaces, interoperability	2024-02-22T20:00:25.805Z	**https://www.linkedin.com/posts/big-data-value-association_bdva-is-glad-to-announce-the-publication-activity-7166388955632910336-hSK-**
The Digital Twin on Climate Adaptation, Sebastian Milinski	Climate Change, ECMWF, DestinationEarth	2024-02-11T02:10:47.612Z	**https://youtube.com/watch?v=W9kjjeJYnO8&si=iWRhvzWkoADQ0iGp**
(2) Post | LinkedIn	Deltares, ECMWF, DestinationEarth, FloodAdapt	2024-02-05T16:57:35.531Z	**https://www.linkedin.com/posts/deltares_enablingdeltalife-digitaltwin-climateadaptation-activity-7160301053672890369-AUxg/?utm_source=share&utm_medium=member_desktop**

Second staff working document on data spaces | Shaping Europe's digital future	data spaces, EuropeanComission	2024-01-29T06:41:11.463Z	**https://digital-strategy.ec.europa.eu/en/library/second-staff-working-document-data-spaces**
Commission launches AI innovation package	AI, EuropeanComission, EuroHPC	2024-01-27T20:48:15.030Z	**https://ec.europa.eu/commission/presscorner/detail/en/IP_24_383**
ISO standard on data spaces officially registered - International Data Spaces	data spaces, ISO, Standards	2024-01-18T01:49:26.755Z	**https://internationaldataspaces.org/iso-standard-on-data-spaces-officially-registered/**
BMWK - IPCEI Next generation Cloud Infrastructures and Services	IPCEI, cloud	2023-12-24T11:37:05.550Z	**https://www.bmwk.de/Redaktion/EN/Artikel/Industry/ipcei-cis.html**
GeoVille: Newsdetail	EOSC, Flood	2023-12-24T06:53:17.517Z	**https://www.geoville.com/news/newsdetail/global-flood-monitoring-report-2022/**
Confirmation of phase two of Destination Earth | ECMWF	ECMWF, DestinE	2023-12-21T03:18:34.135Z	**https://www.ecmwf.int/en/about/media-centre/news/2023/confirmation-phase-two-destination-earth**
BSC plays a significant role in the new EU's challenge to combat climate change: A virtual replica of the Earth | BSC-CNS	DestinationEarth, BSC	2023-12-16T11:14:05.349Z	**https://www.bsc.es/news/bsc-news/bsc-plays-significant-role-the-new-eu%E2%80%99s-challenge-combat-climate-change-virtual-replica-the-earth**
European Commission announces results of the EOSC Procurement - EOSC Association	EOSC, Procurement	2023-12-15T13:51:44.795Z	**https://eosc.eu/news/2023/11/european-commission-announces-results-of-the-eosc-procurement/**
The Eclipse Foundation Launches the Eclipse Dataspace Working Group to Foster Global Innovation in Trusted Data Sharing | Eclipse	eclipse, open source, data spaces	2023-12-13T08:15:23.884Z	**https://newsroom.eclipse.org/news/announcements/eclipse-foundation-launches-eclipse-dataspace-working-group-foster-global**

News, Eclipse in the News, Eclipse Announcement			
Science for Policy Handbook | Knowledge for policy	policy, science	2023-12-11T22:35:29.922Z	**https://knowledge4policy.ec.europa.eu/publication/science-policy-handbook_en**
AI Act: an agreement was reached | BDVA	AI, AI-Act, BDVA	2023-12-11T14:47:59.568Z	**https://bdva.eu/ai-act-reaching-agreement**
Become a Partner of the Pact	ClimateServices	2023-12-11T01:23:28.291Z	**https://climate-pact.europa.eu/get-involved/become-partner-pact_en**
Copernicus: November 2023 – Remarkable year continues, with warmest boreal autumn. 2023 will be the warmest year on record | Copernicus	Copernicus, ECMWF, ClimateServices	2023-12-10T08:55:37.551Z	**https://climate.copernicus.eu/copernicus-november-2023-remarkable-year-continues-warmest-boreal-autumn-2023-will-be-warmest-year**
EUMETSAT Council approves next phase involvement in Destination Earth | EUMETSAT	DestinationEarth, EUMETSAT	2023-12-10T00:52:13.792Z	**https://www.eumetsat.int/eumetsat-council-approves-next-phase-involvement-destination-earth**
Simpl: streamlining cloud-to-edge federations for major EU data spaces (updated October 2023)	SIMPL, data spaces	2023-12-04T13:39:15.570Z	**https://digital-strategy.ec.europa.eu/en/news/simpl-streamlining-cloud-edge-federations-major-eu-data-spaces-updated-october-2023**
Fighting extreme weather with extreme computing power | Research and Innovation	Flood, Hidalgo	2023-12-02T21:35:10.590Z	**https://ec.europa.eu/research-and-innovation/en/horizon-magazine/fighting-extreme-weather-extreme-computing-power**
Realising the potential of AI and HPC | Scientific Computing World	Raise, AI, HPC	2023-12-01T14:32:05.770Z	**https://www.scientific-computing.com/feature/realising-potential-ai-and-hpc**

AI and supercomputers join forces to tackle global challenges	Raise	2023-12-01T14:31:22.199Z	https://cordis.europa.eu/article/id/443638-ai-and-supercomputers-join-forces-to-tackle-global-challenges?WT.mc_id=exp
Believing in Open Science: Interview with Isabel Diaz of CSIC - EOSC Association	open science	2023-12-01T12:38:15.648Z	https://eosc.eu/news/2023/11/believing-in-open-science-interview-with-isabel-diaz-of-csic/
Diego Ciangottini's Speaker Profile	INFN, interLink	2023-11-30T12:25:03.688Z	https://sessionize.com/s/diego-ciangottini/pods-everywhere-interlink-a-virtual-kubelet-abstra/82286
Recommendations for the FUTURE ROADMAP FOR DATA SPACES - News - Data Spaces Support Centre	data spaces, DSSC, Roadmap	2023-11-22T21:55:10.332Z	https://dssc.eu/space/News/blog/223379465/Recommendations+for+the+FUTURE+ROADMAP+FOR+DATA+SPACES
Climate Services cartoon	ClimateServices, impact	2023-11-20T15:21:02.314Z	https://climateurope2.eu/resources/multimedia/cimate-services-cartoon
EGI's contribution to EBDVF 2023 - EGI	BDVF	2023-11-20T14:55:00.156Z	https://www.egi.eu/article/egi-contribution-ebdvf-2023-data-solutions-sustainability/
Site Demonstrators	DT-Geo	2023-11-20T14:48:02.679Z	https://dtgeo.eu/site-demonstrators/
Fenix: A Pan-European Federation of Supercomputing and Cloud e-Infrastructure Services	Fenix, eInfrastructure	2023-11-20T14:35:08.233Z	https://cacm.acm.org/magazines/2022/4/259409-fenix/fulltext#comments
Collection of Standards and Technologies landscape | Version 1.0 | October 2023 - Collection of Standards - Data Spaces Support Centre	Standardization, data spaces, DSSC, interoperability	2023-11-20T11:35:13.152Z	https://dssc.eu/space/SE1/185794561/Collection+of+Standards+and+Technologies+landscape+%7C+Version+1.0+%7C+October+2023

Use Cases Catalogue	DestinationEarth, DestinE, ECMWF	2023-11-13T15:13:56.496Z	https://destination-earth.eu/use-case/
Destination Earth	DestinationEarth	2023-11-13T15:12:41.884Z	https://www.ecmwf.int/en/about/what-we-do/environmental-services-and-future-vision/destination-earth
Joint Workshop | HiDALGO in HiPEAC - HiDALGO2	DigitalTwins, HPC	2023-11-09T22:48:44.010Z	https://www.hidalgo2.eu/joint-workshop-hidalgo-in-hipeac/
A journey through the landscape of ethical AI with etami - European Big Data Value Forum	AI, AI-Ethics	2023-11-09T18:40:39.212Z	https://european-big-data-value-forum.eu/session/a-journey-through-the-landscape-of-ethical-ai-with-etami/
Data Spaces Support Centre: Blueprint v0.5 is out - News - Data Spaces Support Centre	DSSC	2023-11-06T00:03:54.994Z	https://dssc.eu/space/News/blog/184156176/Data+Spaces+Support+Centre%3A+Blueprint+v0.5+is+out
Green Deal Funding Alert - September 2023	GreenDeal	2023-11-01T15:26:29.848Z	https://cor.europa.eu/en/news/Pages/green-deal-funding-alert-september-2023.aspx?trk=feed_main-feed-card_feed-article-content
Call for marine biodiversity (monitoring) data | DTO-BIOFLOW	DT-Oceans, marine	2023-11-01T08:11:46.828Z	https://dto-bioflow.eu/marine-biodiversity-data-open-call
Cloud Optimized GeoTIFF (COG) published as official OGC Standard - Open Geospatial Consortium	OGC, Standards, COG	2023-11-01T07:50:14.102Z	https://www.ogc.org/press-release/cloud-optimized-geotiff-cog-published-as-official-ogc-standard/
EigenRisk Adds Fathom To Its Global Catastrophe Risk Platform	FloodAdapt, Flood, Eigenrisk, Fathom	2023-11-01T07:49:21.114Z	https://www.fathom.global/newsroom/eigenrisk-adds-fathoms-to-catastrophe-risk-platform/

Thales Alenia Space leading a flooding Digital Twin Proof of Concept initiative in Luxembourg | Thales Group	Thales, DigitalTwins, Flood	2023-11-01T07:44:13.133Z	https://www.thalesaleniaspace.com/en/press-releases/thales-alenia-space-leading-flooding-digital-twin-proof-concept-initiative
Initial Common Taxonomy in the Continuum available & Registrations open for next Horizon Europe Calls' Info Session	computecontinuum	2023-10-31T17:49:35.594Z	https://preview.mailerlite.io/preview/185345/emails/103081037750339342
Musk 'considering' pulling X from EU over probe • The Register	communication	2023-10-31T00:07:04.619Z	https://www.theregister.com/2023/10/19/musk_x_europe/
DSSC Glossary | Version 2.0 | September 2023 - Glossary - Data Spaces Support Centre	DSSC, data spaces	2023-10-30T23:26:15.459Z	https://dssc.eu/space/Glossary/176553985/DSSC+Glossary+%7C+Version+2.0+%7C+September+2023
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