



D7.2 Sample of services toolset: a practical guideline

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Deliverable Abstract

This Deliverable describes a minimal set of tools and technologies that proven effective in helping Skills4EOSC Competence Centres achieve their goals. These tools belong to four major classes: (i) tools and solutions for *training management*, (ii) tools and solutions for *collaborative work*, (iii) tools and solutions for *publishing*, (iv) tools and solutions for *virtual laboratories*. The list of tools is complemented by a set of recommendations helping Competence Centres to take informed decisions concerning tools and services to offer to their designated community.

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TERMINOLOGY

<https://eosc-portal.eu/glossary>

| Terminology/Acronym | Definition |
|--------------------------------|--|
| AI | Artificial Intelligence |
| CC | Competence Centre |
| CCNet | Skills4EOSC Coordination Network of Competence Centres |
| CCs | Competence Centres |
| Competence Centre | CCs are organizations/units/initiatives or any entities or reference points that provide specialized expertise and knowledge in a specific field or technology. |
| ELSI | Ethical, Legal and Social Issues |
| EOSC | European Open Science Cloud |
| EOSC-A | European Open Science Cloud Association |
| FAIR | Findable, Accessible, Interoperable, Reusable |
| Skills4EOSC CC | Skills4EOSC CC represent a point of reference in a specific Country/Region/Theme to find key competences to enable the practice of Open Science with adequate knowledge of standards, applications and tools and best practices for delivering, managing, re-using, sharing, and analysing FAIR data, as well as other digital research objects. |
| Skills4EOSC CC Registry | Skills4EOSC CC Registry is an organized collection of entries that serves as a comprehensive resource for finding the necessary competences, standards, tools, and best practices for practising Open Science in a specific Country / Region / Theme. |

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Executive summary

Skills4EOSC Competence Centres are establishing shared hubs of expertise to implement Open Science and FAIR data principles. These centres offer leadership, training, coordination, and cataloguing services to connect relevant stakeholders with guidance, learning resources, and curricula. They operate within their respective countries, regions, or thematic domains.

To fulfil their mission and serve their designated communities, Competence Centres rely on a comprehensive set of tools and IT solutions. Each centre tailors its offerings to meet the specific needs of its community, while also leveraging opportunities from similar initiatives and the availability of new technologies or services.

This deliverable summarizes the project's efforts to identify suitable tools and technologies for Competence Centres. It describes the methodology put in place to collect inputs from Competence Centres. Then it presents an organized array of tools and technologies that have proven effective in helping Competence Centres achieve their goals. In particular, selected tools are organised in four major classes: (i) tools and solutions for **training management**, namely tools CC developers can leverage to provide their designated community with online courses; (ii) tools and solutions for **collaborative work**, namely tools CC developers can leverage to provide their designated community with working environments promoting the collaboration; (iii) tools and solutions for **publishing**, namely tools CC developers can leverage to provide their designated community with access to contents and materials; (iv) tools and solutions for **virtual laboratories**, namely tools CC developers can leverage to provide their designated community with working environments making it possible to experience with real services including cloud-based services.

The deliverable concludes with recommendations helping Competence Centres to take informed decisions concerning tools and services to offer to their designated community.

1 Introduction

One of the core objectives of Skills4EOSC is to establish a robust network of competence centres across Europe. These specialized hubs are designed to foster the development, enhancement, and dissemination of the skills and competencies essential for effectively engaging with and contributing to the European Open Science Cloud (EOSC). Skills4EOSC competence centres are positioned as strategic resources in advancing open science, data management, and cloud computing knowledge, with the overarching aim of cultivating a skilled workforce and promoting the widespread adoption of open science practices across the continent.

Competence centres¹ (CCs) provide a range of tailored services, including consultation, training programs, workshops, and hands-on support, with a focus on building a vibrant community of practice. This community actively exchanges best practices, cultivates new skills, and advances shared standards and methodologies. To facilitate these activities, the competence centres leverage a suite of IT tools and services, such as catalogues and repositories of training materials, learning management systems, and communication and collaboration platforms.

The primary goal of this deliverable is to compile a curated list of open-source tools and solutions that have demonstrated their effectiveness in supporting the establishment and operational needs of competence centres within the Skills4EOSC framework.

The structure of this document is as follows: [Section 2](#) details the methodology employed in identifying and selecting the tools. [Section 3](#) presents an inventory of these tools, offering insights and real-world examples of their successful application in developing Skills4EOSC competence centres. Finally, [Section 4](#) provides a summary of key insights and concluding remarks.

¹ Competence centres are organizations/units/initiatives or any entities or reference points that provide specialized expertise and knowledge in a specific field or technology.

2 Developing the Skills4EOSC Toolset

To identify a suitable set of tools and IT technologies, a comprehensive dual strategy was developed. This approach combined extensive input collection (see Section [2.1](#) and Section [2.3](#)) with targeted interviews and consultations with established Competence Centres (see Section [2.2](#)). This method ensured a thorough and well-rounded understanding of the tools and technologies that would best support the Competence Centres in fulfilling their mission.

2.1 The First Internal Workshop on Competence Centres

The Skills4EOSC Internal Workshop on Competence Centres was held on July 5th, 2023 from 9.30 to 12.30.

The scope of the workshop was to kick off the engagement of national, regional, or thematic Competence Centres within the consortium countries and establish collaboration with Skills4EOSC to adopt the project's outcomes.

The workshop focused on achieving the following goals:

- Understand the different types of Competence Centres in each country.
- Highlight the challenges involved in creating Skills4EOSC nodes at the national, regional, and thematic levels.
- Discuss possible solutions to the challenges faced by competence centres.
- Evaluate whether the Skills4EOSC Competence Centre meets expectations, including its services.
- Share best practices implemented by Skills4EOSC Competence Centres.

In particular, the first session was organised to collect contributions and thoughts helping to define the scope of the competence centres with respect to the Services dimension, i.e. the set of "activities" and facilities CCs personnel have to put in place/to have in their service portfolio to serve the needs of their stakeholders. In order to respond to this goal the following set of questions was identified and used to draw the discussion:

- Q1. In your opinion which stakeholders should the Competence Centre target?

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- Q2. Which field of competence should the CC focus on (e.g., data management, open access, open source software)?
- Q3. As a user, which services and/or resources would you like to find in the CC?
- Q4. As a service provider, which services and/or resources would you like to offer through the CC?

All the questions were open ended thus to make it possible for the participants to reply without any constraint or superimposed bias. The aim was to promote creativity and openness.

2.1.1 Brief report of answers collected for each question

Q1 aim was to collect feedback and opinions about the stakeholders CCs should target. A rich array of classes of stakeholders were suggested ranging from researchers (the most frequent reply) to research data management (RDM) related roles (e.g. professionals, data stewards, trainers, data support personnel, librarians), policy makers, funders. In some cases the class was very wide and comprehensive, e.g. research institutions, RPOs, discipline-specific research communities, any actor of the research lifecycle involved in OS, as many people as who can benefit. Surprisingly, nobody mentioned citizen scientists.

Q2 aim was to collect feedback and opinions about the set of competences and topics the CCs should focus on. The variability of the replies was high. Some of the suggested topics were frequent and expected although very wide (namely, Open Science — including output promotion and valorization —, FAIR, Research Data Management), there were some replies referring to research software and open hardware, a couple of replies referring to open access, just a couple of replies referring to EOSC services and how to benefit from them, a couple of replies on data storage. One reply seems to be related to the discussion stemming from Q1, in fact it was "it strongly depends on the needs at national/regional level and on the actors participating to the CC". One specific reply was about "environmental impact of storage, HPC, etc", a very specific yet wide topic.

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Q3 aim was to collect contributions and expectations with respect to the set of services a user is assuming to find in a CC portfolio. Training activities (including courses and train-the-trainers events) and availability of training resources and material are certainly the most frequent typologies of services expected from the respondents. Some respondents focus instead on consulting-related services, e.g. support for ontology use or OS policy development, availability of best practices and guidelines, help-desk, documentation, practical knowledge on local context. Some of the respondents focus on coordination and networking, e.g. enable collaboration, exchange best practices, announcements of events, training opportunities, representation/voicing of common concerns, access to services in other CCs. Some replies refer to IT services, e.g. RDM tools, catalogues of useful tools and services, tools to facilitate some processes, teaching and learning platforms. One of the replies was about "certification" without any further detail. One of the participants is referring to funds for supporting the development of specific services.

Q4 aim was to enlarge the contributions stemming from Q3 with respect to services CCs should have in their portfolio by exploiting the point of view of a service provider. Although the majority of replies confirm what emerges from Q3 - namely that training and training material are the most common ones followed by consulting and advice-oriented activities - some novelties appeared: (i) 3 respondents report the need to have repositories; (ii) some respondents are highlighting the local dimension, e.g. local use cases, local services, local software, material aligned to local policies, interaction with local stakeholders; (iii) personalised interfaces and AI-based (ChatGPT was referred) interfaces was suggested to simplify the task of "finding" relevant and useful information. One of the participants is responding with "Funds to enable activities and creation of tools, guides, and workflows by discipline-specific research communities".

2.1.2 Take away messages

Considering the variety and extent of stakeholder typologies emerging from Q1, it is paramount for CCs to carefully identify a priority list of stakeholders to target by taking into account the potential services to offer. This will impact

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the development of CC services portfolio. Although each CC has its own autonomy in defining and developing the target stakeholders and the services portfolio it is likely that the Skills4EOSC CCs will identify a common minimum viable set of stakeholders to target and services to offer.

The most common topics stemming from Q2 respondents were the expected ones (FAIR, Open Science, RDM) yet their extent is very wide. It was not easy to figure out how these topics were expected to be addressed, e.g. what is the level of detail envisaged (introductory, expert, both) as well as the expected nature (just informative, theoretical, practical). It is likely that topics (especially if broad) will be shared across CCs yet the level of coverage and the type of support received from specific CCs vary a lot across diverse CCs and strongly depends from what the specific CC can mobilize to address it in terms of human resources and services. The under representation of EOSC-related topics was worth discussing to highlight that EOSC-related training and support is something primarily on the shoulders of others than (Skills4EOSC) CCs that are more focusing on RDM practices in general.

Respondents to Q3 seems to prefer the notion of service in the wider exception, few references to IT services were there. In fact, the great majority expects to have from CCs some form of (authoritative) information by training activities or supported material (training material, documentation, guidelines). Regarding IT tools, CCs should not replicate what is offered by other initiatives (e.g. services offered by EOSC or other service providers and infrastructures), rather should focus on services making the CC a one-stop-shop for the CC designated community by realizing specific directories / catalogues of suitable services properly selected and documented.

Question Q4 is not changing significantly the picture on CC service portfolio emerging from Q3, thus suggesting that the primary services CCs must have in their portfolio are about training and training material as well as RDM-related consulting and advices. However, it is paramount to start discussing how these services are going to be implemented and offered in practice, e.g. Are CC expected to have a specific website, email address, etc.? Are CC expected to offer a catalogue/directory/repository of material they are willing

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to promote to their designated community? Are CC expected to operate an help desk and develop some FAQs?

2.1.3 Open Issues

- **Who are the Skills4EOSC target stakeholders and what are the supported needs?** A minimal viable set of stakeholders forming the **designated community** Skills4EOSC CCs should serve should be defined. Moreover, CC **functional scope** should be carefully defined to avoid false expectations. Services to be offered depends from the designated community and the needs to serve.
- **What's the Skills4EOSC CC capability and capacity?** The skill set Skills4EOSC CCs aim at having on board need to be identified and whether it is possible to envisage common skill set across CCs or not thus having different **capabilities and expertise** in Skills4EOSC CCs. Services to be offered depends from the designated community to be served as well as from the skill set and human and funding resources the CC can count on.
- **What's the Skills4EOSC CC portfolio?** To identify a minimal viable set of services Skills4EOSC CCs should have in their **portfolio**. For every service it should be carefully defined how it is going to be developed and offered (including, if any, recommended tools, technologies, metadata formats, ontologies, etc.) thus to favour common approaches, cooperation and reuse across the boundaries of each CC.

2.2 The continuous dialogue with selected competence centres

The project is developing the [registry of Skills4EOSC Competence Centres](#) [2] as a result of an onboarding methodology. The centres listed here have signed a letter of intent with the project and have established a formal collaboration channel with the project. Hereafter we describe the onboarding methodology (Sec. [2.2.1](#)) and the input collected from the onboarded Competence Centres concerning the services and technology they rely on (Sec. [2.2.2](#)).

2.2.1 Competence Centre Onboarding Methodology

This section outlines the methodology for onboarding Competence Centres into the Skills4EOSC Coordination Network of Competence Centres. The process ensures alignment with the project's goals of promoting Open Science and FAIR data principles across Europe.

Eligibility Criteria and the onboarding process

To be considered for inclusion in the Skills4EOSC CCNet, a Competence Centre must meet the following mandatory requirements:

- Demonstrated commitment to Open Science and FAIR principles;
- Commitment to adopting Skills4EOSC project outcomes;
- Domain authority and expertise;
- Established network of Master Trainers;
- Active engagement with target stakeholder groups;
- Provision of training and support services;
- Effective communication and knowledge dissemination practices.

The onboarding process begins with an initial assessment of the CC's existing activities and expertise. Upon meeting the eligibility criteria, the CC formally commits to adopting Skills4EOSC methodologies and participating in network activities by signing the Memorandum of Understanding. A crucial step in the onboarding process is the training of Master Trainers, who complete the Skills4EOSC Training of Trainers (ToT) program and acquire the necessary Minimum Viable Skillsets (MVSs).

With guidance from Skills4EOSC, the CC develops a comprehensive service portfolio. This includes organizing Training-of-Trainers courses, conducting community-specific training events, and implementing feedback mechanisms. The CC also contributes to the development of new career profiles in Open Science and maintains an active presence within the network.

Integration into the CCNet involves establishing communication channels, accessing shared resources, and inclusion in the Skills4EOSC registry. Throughout the process, ongoing support and regular evaluations ensure continued alignment with project goals and facilitate knowledge sharing across the network.

The Continuous Dialogue with Selected Competence Centers

The process of onboarding Competence Centres (CCs) into the Skills4EOSC network has greatly benefited from the extensive network of contacts established by the project partners. This collaborative effort has been crucial in identifying and engaging suitable institutions to serve as Competence Centres, particularly in countries where such centres were not already established.

Leveraging Project Partners' Networks

Project partners have played a pivotal role in the expansion of the CC network. They have actively sought out and identified institutions at the national level that possess the necessary expertise and resources to effectively function as Competence Centres.

The project coordination, in particular, has been at the forefront of promoting the Competence Centre network: the effort has been mostly spent in raising awareness about the importance of these centres and encouraging suitable institutions to join the network.

Utilizing EOSC Initiatives and Events

The project has also leveraged the broader European Open Science Cloud (EOSC) initiative to expand its reach and promote the CCs network. Numerous conferences, workshops, and seminars related to EOSC and other events have provided excellent platforms for the Skills4EOSC project to showcase its work and highlight the opportunities for institutions to join the network.

These events have served as crucial touch points for engaging with potential Competence Centres, allowing for face-to-face interactions, knowledge sharing, and relationship building. By actively participating in these gatherings, the project has been able to disseminate information about the CC network more effectively and attract interested parties from across the European research landscape.

The Recommendation Guide for Setting Up a CC

To further support the establishment and integration of new Competence Centers, Skills4EOSC has developed a comprehensive Recommendation Guide. This guide² serves as a valuable resource for institutions considering joining the network. The Recommendation Guide was created to address the

² <https://www.skills4eosc.eu/network/competence-centres/setting-up-a-cc>

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need for clear, standardized information on the process of becoming a Competence Centre within the Skills4EOSC network. It outlines the key steps, requirements, and best practices for setting up a CC, ensuring that new centres are well-prepared to contribute effectively to the network's goals.

Key features of the guide include:

- Detailed explanation of the roles and responsibilities of a Competence Centre;
- Step-by-step instructions for the application and onboarding process;
- Guidelines for developing and implementing Open Science training programs;
- Best practices for engaging with local research communities and stakeholders;
- Information on how to integrate with the broader Skills4EOSC network and EOSC ecosystem.

Through these combined efforts – leveraging partner networks, engaging with the EOSC community, and providing clear guidance – Skills4EOSC has fostered a continuous and productive dialogue with selected and potential Competence Centres. This approach has not only facilitated the growth of the CC network but has also enhanced its quality and cohesion.

2.2.2 Skills4EOSC Competence Centres Contributions

Several data collection sessions were organised with the on-boarded Skills4EOSC Competence Centres to develop a list of concrete IT services each CC is operating, get insights about the underlying technologies and the related experiences.

For each service listed by the CC we tried to collect the characteristics described in Table 1.

Table 1. CC services characterising features

| Feature | Description |
|---------------------|--|
| URL | The URL of the service |
| Service class | The typology of service |
| Technology/Software | The primary technology supporting the development of the service |

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| | |
|---------------------|---|
| Service description | A description of the service |
| State | Whether the service is available or planned |
| Target users | Who are the primary users of the service |

In order to not limit a priori the information collectable by the CCs no controlled vocabulary nor fixed set of options was defined.

A total of eight Competence Centres were contacted:

- the Italian Computing and Data Infrastructure (ICDI);
- the Open Science Cloud Competence Center in Greece;
- The CSC Research Data Management Competence Center;
- the Swedish National Data Service (SND);
- the Open Science and Research Data Competence Centre OSC@MK;
- the Recherche Data Gouv;
- the Open Data and Intellectual Property Institute ODIPI ;
- the Luxembourg National Data Service LNDS.

22 Services were described using the schema above. These services range from learning management systems (the most frequent ones) up to ticketing systems and event management systems.

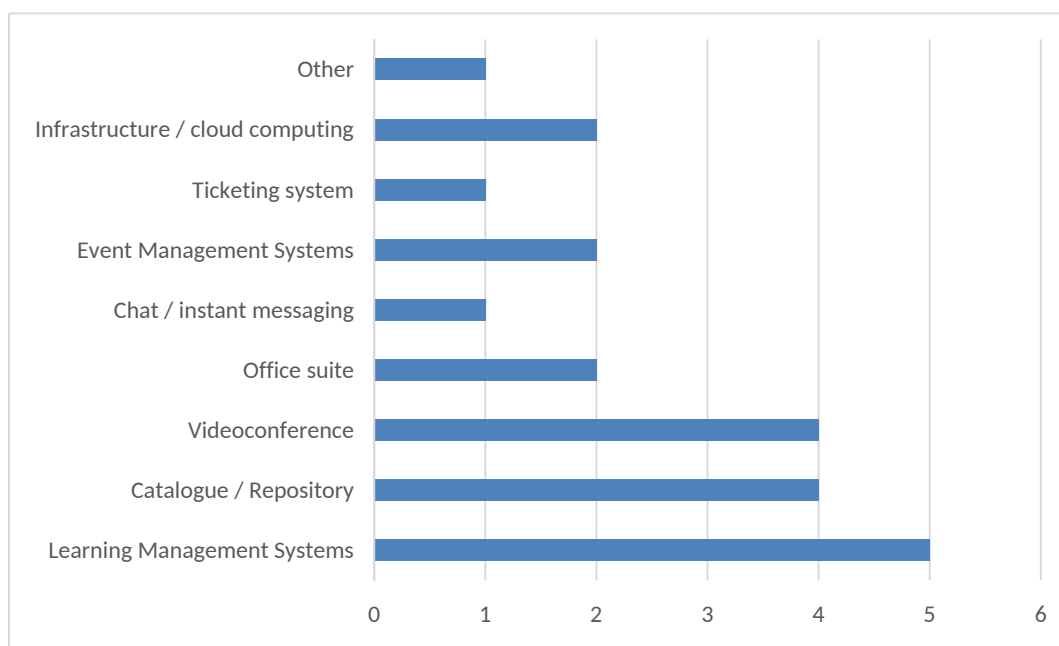


Figure 1. Types of Services operated by CCs

The diagram below emerged from the analysis of the target users characterising the described services. It highlights how the primary class of users targeted by Competence Centres are researchers.

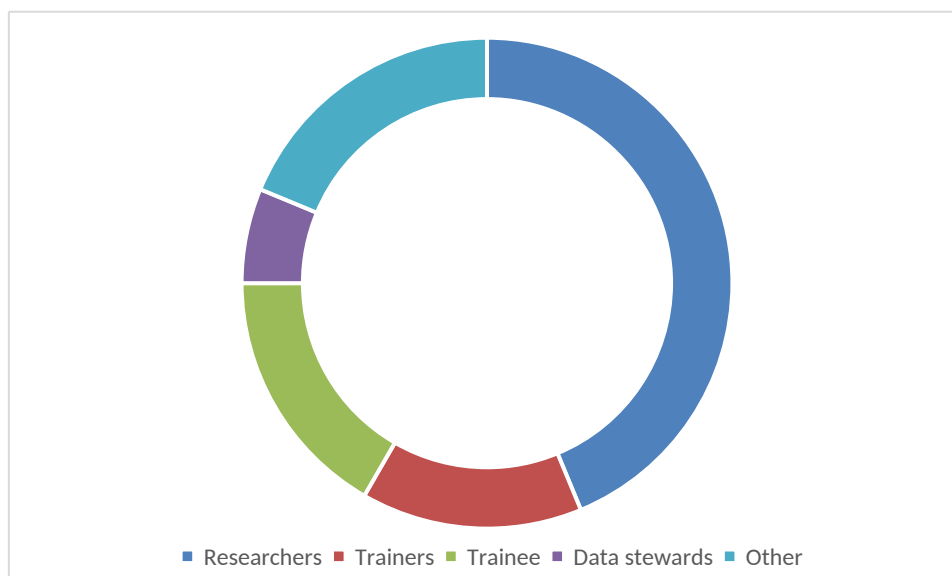


Figure 2. Target users of CCs services

2.3 Open Science Competence Centres in the EOSC and Beyond at EOSC Symposium 2024

Skills4EOSC hosted a co-located workshop and co-organized one of the "unconference" sessions at the EOSC Symposium 2024 (Berlin, 21-23 October) to discuss the Competence Centre network with the community and collect feedback for its further development.

The "unconference" session aimed at examining the roles and definition of Competence Centres within the European Open Science Cloud. In particular, participants were called to discuss the scope of Competence Centres, share initiatives, evaluate impacts, and identify challenges and opportunities.

The workshop took place on the 21st October from 9:00 to 12.30. It was a closed event reserved for Representatives from Skills4EOSC Competence Centres, Skills4EOSC project partners involved in the development of the network and invited participants from related projects or initiatives. It

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consisted of two rounds of moderated discussion with three breakout groups each focusing on the following topics:

Breakout Session 1: Network aspects

- Topic 1 - Implementing the Minimum Viable Skillsets into the competence centre network and country nodes
- Topic 2 - Competence centre vs. EOSC node
- Topic 3 - Network CCs Europe

Breakout Session 2: Competence Centre aspects

- Topic 4 - Sustainability and Governance of the Network
- Topic 5 - Integrating the Data Stewardship Curriculum into Competence Centre Service
- Topic 6 - Network CCs National level

The discussion for each of the topics was structured around three questions. A question about the essential and nice-to-have tools and technologies for Skills4EOSC Competence Centres was included as one of the questions for Topic 6. The discussion group for that topic included representatives from three of the established Competence Centres (Sweden, Greece and France) and representatives from four other organisations that are either considering establishing a Skills4EOSC Competence Centre in their countries or interested in knowing more before they decide. Much of the discussion at the table centred around the different structures of the existing Competence Centres and how the different Competence Centres could help each other by sharing training resources, practices and information, in particular information about relevant contacts in each of the countries. There was broad agreement that it would help to have regular discussions or working groups to further discuss these aspects and that Skills4EOSC project could help facilitate the start of those discussions. Since it is still unclear how these information exchange services could work, no specific tools or technologies were discussed, but it was suggested that this could be the topic of one of the thematic working groups.

3 The Skills4EOSC Toolset

The following set of software tools represent a minimal sample of solutions Competence Centres can rely on to develop its service portfolio.

Tools are organised in four major classes: (i) tools and solutions for **training management** (Sec [3.1](#)), namely tools CC developers can leverage to provide their designated community with online courses; (ii) tools and solutions for **collaborative work** (Sec. [3.2](#)), namely tools CC developers can leverage to provide their designated community with working environments promoting the collaboration; (iii) tools and solutions for **publishing** (Sec. [3.3](#)), namely tools CC developers can leverage to provide their designated community with access to contents and materials; (iv) tools and solutions for **virtual laboratories** (Sec [3.4](#)), namely tools CC developers can leverage to provide their designated community with working environments making it possible to experience with real services including cloud-based services.

Every tool and technology is described by a table following the schema below.

| |
|---|
| Tool Name |
| The official naming of the tool. |
| Tool purpose and overview |
| Describes the primary purpose or function of the tool with respect to Competence Centre goal and mission. |
| Target users |
| The primary audience of the tool (e.g., researchers, data scientists, IT professionals, etc.) and the Skill Level Required (e.g., beginner, intermediate, expert.). |
| Use Cases |
| Provide specific scenarios where the tool was successfully exploited. |
| Technical Specifications |
| Describes technical details including deployment mode, dependencies and requirements. |

| |
|---|
| Licensing and Availability |
| Details on the terms under which the tool can be accessed, used, modified, and distributed as well as how it can be obtained. |
| Integration with EOSC |
| Discusses how the tool is positioned with respect to the EOSC ecosystem. |
| References |
| Describe sources of information for the tool, namely a website and any other worth mentioning source. |

3.1 Tools and Solutions for Training Management

These tools aim to streamline the planning, execution, and evaluation of training programs, ensuring that they are effective, efficient, and aligned with the needs of the researchers and data professionals the Competence Centres are addressing.

Among these tools, Moodle (Sec. [3.1.1](#)) plays a primary role since it proven to work in Competence Centres experiences as well as BBB (Sec. [3.1.2](#)) and Jitsi (Sec. [3.1.3](#)) for online communication and training.

3.1.1 Moodle

| |
|---|
| Tool Name |
| Moodle - Modular Object-Oriented Dynamic Learning Environment |
| Tool purpose and overview |
| <p>Moodle is an open-source learning management system (LMS) designed to provide educators, administrators, and learners with a robust, secure, and customizable platform for creating personalized learning environments.</p> <p>It enables online course delivery, blended learning, and content management. It supports collaborative learning through forums, quizzes, assignments, grading, and communication tools.</p> |

Target Users

The primary audience comprise Educators, trainers, students, and academic institutions.

Skill Level Required: Beginner (for basic use) to expert (for advanced customizations).

Use Cases

The Italian Competence Centre, [ICDI](#) (Italian Computing and Data Infrastructure), part of the Skills4EOSC project network, has been organizing since 2021, in collaboration with GARR (the National Research and Education Network), a series of courses called Open Science Café. The Open Science Café is a monthly appointment focusing on themes and updates from the Open Science world, designed for the Italian scientific community to inform and discuss various aspects of open science informally during coffee time. Each webinar lasts one hour and focuses on a specific topic, always allowing time for discussion.

The series targets researchers, students, research support staff, organizations, institutions, and citizens interested in exploring Open Science topics, learning about national and European initiatives, and staying informed about the latest developments. The course series is created and managed through GARR's Moodle platform (<https://learning.garr.it>). For each session, a specific course is opened and registration is enabled for users with a platform account. Users are notified of course openings through the platform's News Forum and GARR and ICDI's web and social media channels.

Once enrolled, users find the following information on the course page:

- Course date and time
- Course type
- Abstract and detailed program
- Instructor biographies
- Target audience
- Information about the Open Science Café series
- Information about ICDI
- Video streaming link

After the webinar, the course page is updated with:

- Instructors' presentation slides

D7.2 Sample of services toolset: a practical guideline

- Video recording of the course
- Any additional educational materials (links, in-depth texts)

Enrolled users can independently download a certificate of participation from the course page after completing a satisfaction questionnaire. This questionnaire evaluates course satisfaction and collects valuable feedback to improve future Open Science Café offerings and plan subsequent sessions based on user input. All webinars are recorded and made available on the GARR Learning platform, allowing those who could not attend the live session to access the content asynchronously, thus expanding the user base.

The GARR Learning platform currently runs on Moodle version 4.1 and has approximately 12,700 registered users.

Technical Specifications

Moodle is a web-based tool that can be either self-hosted or made available by [MoodleCloud](#), the hosting service provided by Moodle.

It is primarily developed in PHP and requires a Web server (e.g., Apache, Nginx), a Database (e.g., MySQL, PostgreSQL), and the PHP environment to work.

Licensing and Availability

The Moodle software is released under the terms of the of the [GNU General Public License](#).

The software is made available via the [Moodle website](#) or via the as-a-Service delivery mode via the [MoodleCloud](#).

Integration with EOSC

From the EOSC perspective a Moodle instance is both a service on its own and a repository of training material. The onboarding of Moodle instances operated by Competence Centres into EOSC is paramount to foster Open Science education.

References

Moodle official website: <https://moodle.org>

3.1.2 BigBlueButton

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| Tool Name |
| BigBlueButton (BBB) |
| Tool purpose and overview |
| BigBlueButton is an open-source virtual classroom software designed to enhance online learning. It provides a comprehensive set of tools for real-time sharing of audio, video, slides (with whiteboard annotations), chat, and screen. The platform is built to support educators in delivering interactive and engaging virtual classes, making it easier for teachers to teach and learners to learn. |
| Target users |
| Target users include educational institutions (Schools, colleges, and universities for conducting online classes), trainers (for delivering training sessions and workshops), non-profit organizations (to facilitate remote learning and training programs) as well as agencies (for conducting virtual meetings and training sessions). |
| Use Cases |
| The tool is suitable for several cases including virtual classrooms, webinars and workshops, as well as remote meetings and training sessions. |
| Technical Specifications |
| The platform is accessible via any web browser and provides APIs for integration with Learning Management systems including Moodle. |
| Licensing and Availability |
| BigBlueButton is open-source software licensed under the Lesser General Public License (LGPL). It is freely available for anyone to use, modify, and distribute. The source code is hosted on GitHub . |
| Integration with EOSC |
| While BigBlueButton itself is not specifically integrated with the European Open Science Cloud, it can be used to support virtual meetings and training sessions within EOSC projects. Its open-source nature and robust feature |

set make it a valuable tool for collaborative research and education initiatives.

References

BigBlueButton website <https://bigbluebutton.org/>

3.1.3 Jitsi

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| Tool Name |
| Jitsi |
| Tool purpose and overview |
| Jitsi is a collection of open-source projects that provide secure and scalable video conferencing solutions. At its core are Jitsi Videobridge and Jitsi Meet, which enable high-quality video conferences over the internet. Jitsi supports a wide range of features including audio, video, screen sharing, and chat, making it a versatile tool for virtual communication. |
| Target users |
| Target users include educational institutions (Schools, colleges, and universities for conducting online classes), trainers (for delivering training sessions and workshops), non-profit organizations (to facilitate remote learning and training programs) as well as agencies (for conducting virtual meetings and training sessions). |
| Use Cases |
| The tool is suitable for several cases including virtual classrooms and meetings, webinars and workshops, as well as remote meetings and training sessions. |
| Technical Specifications |
| The platform is accessible via any web browser as well as popular OS and provides APIs for integration with Learning Management systems including Moodle. |
| Licensing and Availability |
| Jitsi is open-source software licensed under the Apache 2.0 license. It is |

freely available for anyone to use, modify, and distribute. The source code is hosted on [GitHub](#).

Integration with EOSC

While Jitsi itself is not specifically integrated with the European Open Science Cloud, it can be used to support virtual meetings and collaborative research within EOSC projects.

References

Jitsi website <https://jitsi.org/>

3.2 Tools and Solutions for Collaborative Work

Effective collaboration is crucial for advancing open science and ensuring seamless cooperation among researchers, data professionals, and other stakeholders. The tools highlighted here facilitate the sharing of files, the collaborative editing of contents and the communication among members.

Selected tools include ONLYOFFICE (Sec. [3.2.1](#)) and Nextcloud (Sec [3.2.2](#)) as office suites, and Mattermost (Sec. [3.2.3](#)) as collaboration platform, and Zulip (Sec. [3.2.4](#)) as communication platforms.

3.2.1 ONLYOFFICE

| Tool Name |
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| ONLYOFFICE |
| Tool purpose and overview |
| ONLYOFFICE is an open-source office suite designed to enhance productivity and collaboration. It provides powerful online document editors and a comprehensive platform for document management, project management, CRM, and email. ONLYOFFICE aims to streamline workflows and improve efficiency within organizations, aligning with the Competence Centre's goal of fostering effective collaboration and data management. |
| Target users |

The primary audience for this tool include Researchers, Data Scientists, IT Professionals, Administrative Staff.

The Skill Level Required range from Beginner to Expert.

Use Cases

The Italian Competence Centre ICDI (Italian Computing and Data Infrastructure) relies on OnlyOffice as a critical platform for document management and collaboration. It serves as a unified repository for meeting minutes, strategic documents, and other essential resources, enabling seamless organization and controlled access. Documents are structured into folders aligned with the Centre's operational hierarchy. These include spaces for the Executive Board and various working groups, each with tailored permissions to safeguard sensitive information and ensure relevant access.

OnlyOffice supports collaborative editing, allowing ICDI members to work on shared documents in real time, fostering efficiency and teamwork. The platform's comprehensive compatibility with multiple file formats ensures smooth integration with existing workflows and tools, enhancing usability across diverse projects. Additionally, its deployment as a self-hosted solution underscores ICDI's commitment to data sovereignty and adherence to internal security policies. Through features like real-time editing, version control, and advanced access management, OnlyOffice proves instrumental in advancing the ICDI Competence Centre's collaborative efforts while maintaining high standards of data organization and security.

Technical Specifications

The tool deployment mode is as SaaS or on-premises.

Dependencies and Requirements: Compatible with Windows, macOS, Linux, Android, and iOS. Requires a modern web browser for online use, the version of interest for Skills4EOSC CCs.

Supported Formats include DOCX, XLSX, PPTX, ODT, DOC, RTF, EPUB, MHT, HTML, ODS, XLS, CSV, ODP, PPT, PDF.

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| Licensing and Availability |
| ONLYOFFICE is an open source software released under the terms of the GNU Affero General Public License v.3 . The free version can be downloaded from the technology website and self-hosted. |
| Integration with EOSC |
| Instances of ONLYOFFICE can be onboarded in EOSC as well as integrated with EOSC services, namely the EOSC AAI. |
| References |
| ONLYOFFICE official website: https://www.onlyoffice.com/ |

3.2.2 Nextcloud

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| Tool Name |
| Nextcloud |
| Tool purpose and overview |
| Nextcloud is an open-source tool designed for online file storage and sharing. It functions similarly to services like Dropbox, Office 365, and Google Drive. Files are organized in conventional directory structures and can be accessed via WebDAV. User files are encrypted during transit and can be synchronized with local clients on Windows, macOS, or various Linux distributions. Nextcloud allows free access to your data across multiple devices, whether mobile or desktop, and facilitates information exchange between multiple users, whether they have accounts or not. |
| Target users |
| Nextcloud caters for various users, each leveraging its robust features. |
| Use Cases |
| Nextcloud creates a collaborative work environment where teams can easily share, edit, and manage documents. This system is perfect for organizations that need to maintain version control of their documents and minimize email exchanges. Additionally, Nextcloud provides robust data privacy controls, ensuring that sensitive information remains secure |

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| during collaborations. |
| Technical Specifications |
| Nextcloud is a versatile, open-source platform that runs primarily on Linux-based systems with Apache or Nginx web servers and supports databases like MySQL/MariaDB, PostgreSQL, or SQLite, requiring PHP 7.4 or newer. |
| Licensing and Availability |
| Nextcloud is distributed under the AGPLv3 (GNU Affero General Public License version 3), which guarantees users the freedom to use, study, share, and modify the software. It is available for download directly from the official Nextcloud website and can be installed on either a personal or hosted server. |
| Integration with EOSC |
| Nextcloud can be integrated with the EOSC AAI infrastructure, and it also supports REST API for custom integrations and extensions. |
| References |
| Nextcloud official website: https://nextcloud.com |

3.2.3 Mattermost

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|---|
| Tool Name |
| Mattermost |
| Tool purpose and overview |
| Mattermost is an open-source software solution that offers a secure and customizable team collaboration platform. With its messaging, file sharing, and integrations capabilities, Mattermost facilitates real-time communication and knowledge sharing among teams, making it easy to align and share information across teams and institutions. |
| Target users |
| Mattermost is ideal for various users, wanting an open source alternative to communicating amongst teams. |

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| Use Cases |
| Mattermost is a versatile collaboration platform suitable for supporting various workflows going well beyond the Competence Centres ones. In fact, it was exploited to support teams collaboration and projects management. |
| Technical Specifications |
| Mattermost is an open core, self-hostable collaboration platform that offers persistent chat & ChatOps, workflow, and toolchain automation, screen, file, and content sharing, and AI-enhanced information synthesis. |
| Licensing and Availability |
| The Mattermost software comes on three versions: Mattermost Team Edition, Mattermost Enterprise with no subscription and Mattermost Enterprise Edition with subscription. The Team Edition is available Open Source, with an Open Source MIT License. Open Source Add-ons for this version of the software are available under Apache version two and other licenses. The Mattermost Enterprise Editions are under a Commercial Enterprise Edition License. However, users are able to use the Mattermost Enterprise Edition with no subscription free of charge when there is no license key enabled. There are no subscription terms when operating Mattermost without a subscription. There are terms when users enable a license key and use Mattermost’s Enterprise Edition with a subscription |
| Integration with EOSC |
| Mattermost provides different ways to add functionality and customisability. Open source integrations are available via the Mattermost Marketplace, but there is also plugins available, including GitHub Plugin and Zoom Plugin. Mattermost suggests that plugins are the most comprehensive way to add new features and customisation to self-host Mattermost deployments. In addition to open source integration and plugins, Mattermost gives complete access to server APIs (Application Programming Interface) via their API Reference, along with language-specific drivers to integrate within applications. |
| References |

Mattermost website: <https://mattermost.com>

Mattermost overview: <https://docs.mattermost.com/about/product.html>

Mattermost open-source licensing and terms of use and privacy policy: <https://docs.mattermost.com/about/faq-license.html>

Mattermost integrations overview: <https://docs.mattermost.com/about/integrations.html>

3.2.4 Zulip

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| Tool Name |
| Zulip |
| Tool purpose and overview |
| Zulip is an open-source team collaboration tool that combines the best features of email and chat. It is designed to facilitate both live and asynchronous conversations through its unique topic-based threading model. |
| Target users |
| Target users include organizations and remote teams as well as educational institutions (eg for coordination between staff and students as well as during online classes). |
| Use Cases |
| Use cases range from team communication to remote collaboration education and training. |
| Technical Specifications |
| The platform is available on web browsers as well as many OS. It offers API facilitating the integration with other applications. |
| Licensing and Availability |
| Zulip is open-source software licensed under the Apache 2.0 license. It is freely available for anyone to use, modify, and distribute. The source code is hosted on GitHub . |

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| Integration with EOSC |
| While Zulip itself is not specifically integrated with the European Open Science Cloud, it can be used alongside EOSC services for communication and collaboration within research projects. |
| References |
| Zulip website https://zulip.com/ |

3.3 Tools and Solutions for Publishing

Competence Centres rely on repositories, catalogues and other platforms to organizing, storing, publishing and making FAIR any material of interest for their designated community. The typologies of material are almost open ended ranging from training material to policies, datasets, technical documentation, etc.

Selected tools include DSpace (Sec. [3.3.1](#)) and Dataverse (Sec. [3.3.2](#)) as repositories, Catalogue as-a-Service (Sec. [3.3.3](#)) as platform for collaboratively developing community-driven catalogues, Open Journal Systems (Sec. [3.3.4](#)) as platform for developing open journals.

3.3.1 DSpace

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| Tool Name |
| DSpace |
| Tool purpose and overview |
| DSpace is a free and open-source software platform for building digital repositories. Its main purpose is to capture, store, index, preserve, and distribute digital content, making it popular among academic, research, and cultural institutions globally. |
| Target users |
| DSpace is designed to serve a diverse range of users across various institutions, including academic and research institutions, libraries, cultural heritage organizations, government agencies, research consortia, and non- |

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| profits. |
| Use Cases |
| DSpace is utilized by various institutions for several primary use cases, including Institutional Repositories, Digital Archives, Research Data Repositories, and Theses and Dissertation Collections. |
| Technical Specifications |
| DSpace is compatible with multiple operating systems, such as Linux, Windows, and macOS. It requires Java Development Kit (JDK) version 8 or newer. Typically, Apache Tomcat serves as the servlet container, and it supports either PostgreSQL or Oracle as the database. |
| Licensing and Availability |
| DSpace is distributed under the BSD open-source license, which enables institutions to freely use, modify, and distribute the software with minimal restrictions. DSpace can be downloaded for free from the official DSpace website or from various software repositories. |
| Integration with EOSC |
| DSpace can be integrated with the EOSC AAI infrastructure and the OpenAIRE aggregator. |
| References |
| DSpace official website: https://dspace.org |

3.3.2 Dataverse

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|---|
| Tool Name |
| Dataverse |
| Tool purpose and overview |
| Dataverse is an open-source web application designed to share, preserve, cite, explore, and analyze research data. It aims to facilitate data sharing and replication of research, enhancing transparency and collaboration among researchers |

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| Target users |
| <p>Primary Audience include researchers, data authors, publishers, data distributors, and affiliated institutions.</p> <p>Skill Level Required range from beginner to expert, depending on the specific use case and integration needs.</p> |
| Use Cases |
| <p>Used by the France Competence Centre to implement the Recherche Data Gouv, i.e. the France national ecosystem realising a multidisciplinary repository for sharing and opening research data.</p> |
| Technical Specifications |
| <p>Dataverse can be deployed on local servers or cloud environments.</p> <p>It requires Java, PostgreSQL, and Glassfish or Payara server for deployment.</p> <p>It also supports integration with various external tools for enhanced functionality.</p> |
| Licensing and Availability |
| <p>Dataverse is available under the Apache License 2.0, allowing users to access, use, modify, and distribute the software freely. It can be obtained from the official GitHub repository.</p> |
| Integration with EOSC |
| <p>Dataverse is designed to be interoperable with the European Open Science Cloud ecosystem, supporting standards and protocols that facilitate data sharing and integration within the EOSC framework.</p> |
| References |
| <p>Dataverse Website: https://dataverse.org/</p> |

3.3.3 Catalogue as-a-Service

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|------------------------|
| Tool Name |
| Catalogue as-a-Service |

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| Tool purpose and overview |
| <p>This service provides any community of practice with a catalogue service for publishing any research resource and making it FAIR. Research resources published by the catalogue are fully controlled by the community itself regarding the metadata characterising them, the typologies of resources publishable, the workflows governing the publishing (eg online first, open peer review), the users allowed to publish resources and the resource items finally published. Every catalogue instance is accompanied by a virtual research environment supporting the collaborative development of catalogue contents.</p> |
| Target users |
| <p>Primary Audience include researchers, resource authors, publishers, distributors, and affiliated institutions.</p> <p>Skill Level required range from beginner to expert, depending on the specific use case and integration needs.</p> |
| Use Cases |
| <p>This solution was successfully exploited in several scenarios goes well beyond the Competence Centres. Concerning the Competence Centers, it was exploited in the context of the Italian Competence Centre to set up and develop its catalogue https://open-science.it/catalogue (currently, collecting and publishing institutional Open Access and Open Data policies).</p> <p>Another use case close to CC needs is represented by the EOSC-Pillar Training and Support Catalogue, a catalogue of very diverse training and support material for data stewardship and research data management collaboratively developed via a dedicated supporting environment.</p> |
| Technical Specifications |
| <p>The solution is offered as-a-Service by the D4Science infrastructure.</p> <p>It is part of the gCube Software System^{3,4}, an open source software, and primarily relies on the the CKAN open source software for the</p> |

³ <https://code-repo.d4science.org/gCubeSystem>

⁴ <https://code-repo.d4science.org/gCubeCI/gCubeReleases>

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| implementation of the back-end. |
| Licensing and Availability |
| <p>The gCube software is released under the terms of the EUPL V.1.1 License.</p> <p>The primary exploitation mode of this tool is as-a-Service, thus CCs willing to rely on it should contact the D4Science team. Every service instance will be hosted on D4Science premises yet the management is completely in the hands of the CC concerning users and contents. Every service instance will be made available by a dedicated gateway.</p> |
| Integration with EOSC |
| <p>Every catalogue is a new resource for the EOSC federation and will have its access policy defined by the community driving its development. Concerning the added value to the EOSC Federation, catalogues instances are community-driven data sources facilitating the publishing and FAIRness of new resources. Allowing communities to easily and collaboratively develop catalogues enlarges the amount of resources made available.</p> |
| References |
| D4Science website: www.d4science.org |

3.3.4 Open Journal Systems

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| Tool Name |
| Open Journal Systems (OJS) |
| Tool purpose and overview |
| <p>Open Journal Systems (OJS) is an open-source software application for managing and publishing scholarly journals online. It provides a comprehensive solution for the entire editorial workflow, including article submission, peer review, and online publication.</p> |
| Target users |
| <p>Target users include Academic institutions, Research organizations, Independent scholars, Librarians, Journal editors and managers.</p> <p>Skill Level required range from beginner to expert, depending on the</p> |

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| specific use case and integration needs. |
| Use Cases |
| Several Universities are exploiting OJS to develop their scholarly journals. According to OJS " more than 8 million items have been published with Open Journal Systems ". For instance, the University of Tartu is operating it to support 24 journals https://ojs.utlib.ee/ |
| Technical Specifications |
| OJS is developed in PHP and requires RDBMS to work (MySQL/MariaDB and PostgreSQL). It can be hosted on any web server. |
| Licensing and Availability |
| OJS is released under the GNU General Public License, allowing free use and modification. It can be downloaded and installed on a local server. |
| Integration with EOSC |
| OJS is working towards integration with the European Open Science Cloud (EOSC) through a plug-in that aligns with the EOSC Interoperability Framework. This integration aims to enhance interoperability among institutional publishing platforms and ensure compliance with open science standards. |
| References |
| Open Journal Systems website https://pkp.sfu.ca/software/ojs/ |

3.4 Tools and Solutions for virtual laboratories

Competence Centres might rely on several solutions to provide their designated community with working environments enabling the practical experimentation of several services and technologies subjects of the training activities including virtual research environments (Sec. [3.4.1](#)) and data management plan platforms (Sec. [3.4.2](#) and Sec. [3.4.3](#)).

3.4.1 Virtual Research Environment as-a-Service

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| Tool Name |
| Virtual Research Environment-as-a-Service |
| Tool purpose and overview |
| <p>This platform provides any community of practice with a dedicated working environment promoting a collaborative and open-science-friendly knowledge production process. D4Science-based VREs are web-based, community-oriented, collaborative, user-friendly, open-science-enabler working environments for scientists and practitioners willing to work together to perform a set of (research) tasks. From the end-user perspective, each VRE manifests in a unifying web application (and a set of application programming interfaces (APIs)): (a) comprising several interoperable applications organised in specific menu items and (b) running in a plain web browser. Every application provides VRE users with facilities implemented by relying on one or more services provisioned by diverse providers. Among the applications in each VRE there is (i) a Social Networking area enabling collaborative and open discussions on any topic and disseminating information of interest for the community, for example, the availability of a research outcome; (ii) a Workspace for storing, organizing and sharing any version of a research artifact, including dataset and model implementation; (iii) a User Management dashboard for managing membership and roles; (iv) a Catalogue Service recording the assets worth being published thus to make it possible for others to be informed and make use of these assets. The set of applications in a VRE can be extended by borrowing additional ones from D4Science and/or by integrating community-specific ones via well-established integration patterns.</p> |
| Target users |
| <p>Primary Audience include researchers, resource authors, publishers, distributors, and affiliated institutions.</p> <p>Skill Level required range from beginner to expert, depending on the specific use case and integration needs.</p> |

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| <p>Use Cases</p> <p>Hundreds of Virtual Research Environments were developed and operated to serve diverse use cases and communities of practices going well beyond the current horizons of Competence Centres. In the context of the EOSC-Pillar a couple of VREs were created to support educational activities: namely to support a course on practising Open Science in the context of earth science and to support a course on practising Open Science in the context of human sciences and cultural heritage. In the context of the Italian Competence Centres a VRE was proposed to support the activities of the national data steward community.</p> |
| <p>Technical Specifications</p> <p>The solution is offered as-a-Service by the D4Science infrastructure. It is part of the gCube Software System^{5,6}, an open source software specifically designed and developed to support the operation of infrastructures enabling the creation of Virtual Research Environments as-a-Service.</p> |
| <p>Licensing and Availability</p> <p>The gCube software is released under the terms of the EUPL V.1.1 License. The primary exploitation mode of this tool is as-a-Service, thus CCs willing to rely on it should contact the D4Science team. Every service instance will be hosted on D4Science premises yet the management is completely in the hands of the CC concerning users and contents. Every service instance will be made available by a dedicated gateway.</p> |
| <p>Integration with EOSC</p> <p>Every VRE is a new resource for the EOSC federation and will have its access policy (defined by the requester) that is either (a) "open access", every EOSC user is allowed to use it; (b) "restricted", every EOSC user can apply to use it, and the VRE requester may approve or reject the membership request,</p> |

⁵ <https://code-repo.d4science.org/gCubeSystem>

⁶ <https://code-repo.d4science.org/gCubeCI/gCubeReleases>

and (c) "by invite", the VRE community explicitly invites members to join. Concerning the added value to the EOSC Federation, VREs (aka Science Gateway) proved to be effective solutions for communities of practices willing to exploit digital resources to perform scientific investigations crossing the boundaries of labs and institutions. They are crucial in modernizing the research landscape, fostering innovation, and enabling more effective and impactful scientific discoveries. Every VRE will contribute to the development of EOSC by facilitating the release of resources produced by its exploitation into the EOSC resource space.

References

D4Science website: www.d4science.org

3.4.2 ARGOS / OpenDMP

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| Tool Name |
| ARGOS / OpenDMP |
| Tool purpose and overview |
| Argos is an open platform developed by OpenAIRE and EUDAT for Data Management Planning (DMP). It simplifies the creation, validation, monitoring, and maintenance of DMPs, ensuring they adhere to FAIR (Findable, Accessible, Interoperable, Reusable) and Open Science best practices. Argos allows users to create machine-actionable DMPs that can be freely exchanged among infrastructures, enhancing the quality and integrity of research data. |
| Target users |
| Target users include researchers willing to create and share DMPs as well as institutions supporting the development of data management practices. |
| Use Cases |
| Use cases include all the scenarios where RDMs are created, published and reused including the management of RDMs for training and testing purposes. |

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| Technical Specifications |
| ARGOS is primarily offered as-a-Service and can be exploited via a plain web browser. |
| Licensing and Availability |
| Argos is based on OpenDMP , an open-source software that can be deployed by third parties. It is freely available through the OpenAIRE Service Catalogue and the EOSC Catalogue. |
| Integration with EOSC |
| Argos is integrated within the OpenAIRE platform and is offered through the EOSC Catalogue. It enhances the OpenAIRE Research Graph and utilizes EOSC services to add value to DMPs, ensuring they are compliant with Open Science and FAIR principles. |
| References |
| Argos website https://argos.openaire.eu/ |

3.4.3 DMPonline

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| Tool Name |
| DMPonline |
| Tool purpose and overview |
| <p>Funding bodies increasingly require their grant-holders to produce a Data Management Plan (DMP), both during the bid preparation stage and after funding has been secured. DMPonline helps research teams respond to this requirement and any expectations that their institution or others may apply. DMPonline is a user-friendly, web-based tool designed to empower researchers in developing high quality data management and sharing plans.</p> <p>Within the tool, researchers will find a wealth of custom guidance, structured best practice guidelines, the latest funder templates, and example answers. The Digital Curation Centre (DCC), research funders, and many research organisations contribute to this resource. Users can also browse the growing list of public DMPs published by other tool users for</p> |

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| <p>inspiration.</p> |
| <p style="text-align: center;">Target users</p> <p>DMPonline is a versatile tool designed to serve a diverse group of users, primarily focusing on researchers engaged in crafting their Data Management Plans (DMPs).</p> <p>In addition to aiding researchers, DMPonline caters to administrative professionals within institutions. These administrators have the capability to tailor the tool's features to better fit the specific needs of their organisation, enhancing the functionality and user experience.</p> <p>Furthermore, DMPonline encourages collaboration amongst funders and institutional partners, who come together to refine and enhance the tool. This collaborative approach not only improves the tool's utility but also ensures it evolves to meet the changing standards and expectations of data management in research environments. Thus, DMPonline serves as a comprehensive resource for creating, customising, and enhancing data management practices across the research community.</p> |
| <p style="text-align: center;">Use Cases</p> <p>Creating and Drafting DMPs: Researchers primarily use DMPonline to craft, draft, and refine their DMPs. The platform provides template-based guidance, aiding researchers in ensuring their plans meet necessary standards and include specific guidance on data handling throughout their research lifecycle.</p> <p>Customisation by Institutions: Universities and other research institutions use DMPonline to configure the platform according to their specific needs and guidelines. This includes creating institutional templates, embedding tailored advice, and modifying the tool to closely match local data management policies and infrastructures.</p> <p>Review and Feedback: DMPonline also facilitates the process of reviewing and giving feedback on DMPs. Supervisors, collaborators, and designated reviewers can access, comment on, and contribute to improving the quality and applicability of the plans.</p> <p>Training and Education: The platform serves as an educational tool for researchers, particularly those new to data management concepts.</p> |

Through interactive guides and structured advice, DMPonline helps users understand data stewardship best practices and the specific requirements of their funders and institutions.

Testing and Educational DMPs: DMPonline is useful for creating test DMPs which can be used for training purposes or for testing the implementation of new institutional policies or funder requirements without affecting actual research data. This feature is particularly valuable in educational settings, helping learners to practice data management planning in a risk-free environment.

Collaborative Planning: DMPonline facilitates collaborative planning for projects involving multiple researchers or institutions, promoting coherent data management practices across disciplines and organizational boundaries.

Integration with Institutional Services: Many institutions integrate DMPonline with other internal systems like institutional repositories or data storage services to streamline data management throughout its lifecycle.

Adaptation to New Standards and Regulations: As data management standards and regulations evolve, DMPonline allows for quick template and guidance updates, ensuring that researchers have access to current information and best practices.

Technical Specifications

DMPonline is a web-based tool and can be accessed from a web browser. The DMPonline team operates a responsive helpdesk service and actively engages with the user community, ensuring that all voices can shape the development roadmap.

Licensing and Availability

DMPonline is open source and the [source code is on github](#). DMPonline is not just a tool; it's a community and it is committed to inclusivity. Services are offered for free to all researchers. Institution subscriptions are available for customisation of the service.

Integration with EOSC

DMPonline is part of EOSC catalogue - <https://eosc.eu/eosc->

[practice/dmponline/](#).

References

DMPonline website <https://dmponline.dcc.ac.uk/>.

4 Recommendations

When selecting the right tools for deployment, several generic key principles should be considered.

1. Open Source and Interoperability

- a. Prioritize tools that are **open-source** and adhere to **open standards** to foster innovation and ensure long-term sustainability. Open-source solutions allow for customization and community-driven improvements.
- b. Ensure tools support **interoperability** by adhering to standards for data formats, metadata, and APIs, facilitating integration with other systems and platforms, including EOSC services.

2. Scalability and Flexibility

- a. Choose tools that can **scale** to meet growing needs and handle varying workloads. Opt for solutions with **modular architectures** that can adapt to different projects and research environments.
- b. Tools should be flexible enough to accommodate diverse user needs, from basic users to advanced researchers.

3. Security and Data Protection

- a. Implement tools with robust **security features** such as encryption, access controls, and audit trails to protect sensitive data.
- b. Ensure all tools comply with **GDPR** and other relevant data protection regulations, particularly those handling personal or sensitive data.

4. User Experience and Accessibility

- a. Focus on tools with **intuitive user interfaces** and comprehensive documentation. User-friendly tools promote wider adoption and more effective use.
- b. **Accessibility** features should be considered to accommodate users with different needs, ensuring inclusivity.

5. Adhering to FAIR Data Principles

- a. Ensure that the selected tools support the creation, curation, and management of **FAIR data**, including the ability to link datasets,

D7.2 Sample of services toolset: a practical guideline

publications, and other digital objects across repositories and services.

- b. Use **persistent identifiers** for data, employing standardized metadata to describe data sets, and providing clear licensing that specifies how data can be reused.

6. Deployment Models

- a. **Self-hosted solutions** offer greater control, customization, and data security but require in-house expertise and resources.
- b. **Third-party hosted services** (e.g., cloud platforms) may reduce maintenance overhead but could introduce data sovereignty concerns.
- c. A **hybrid approach**—where core services are self-hosted, and supplementary tools are outsourced—can balance control and convenience.

5 Conclusion

This deliverable first describes the process followed to gain an understanding of the needs and requirements of Skills4EOSC Competence Centres for tools and technologies to deliver their services, then the deliverable identifies and documents a set of tools and ICT technologies suitable for Competence Centres, namely technologies that have proven to be effective in helping Competence Centres achieve their goals. The focus was on open-source technologies or tools deployed by exploiting open-source technologies and made available by non-commercial players.

Selected tools were organised in four major classes: (i) tools and solutions for **training management**, namely tools CC developers can leverage to provide their designated community with online courses; (ii) tools and solutions for **collaborative work**, namely tools CC developers can leverage to provide their designated community with working environments promoting the collaboration; (iii) tools and solutions for **publishing**, namely tools CC developers can leverage to provide their designated community with access to contents and materials; (iv) tools and solutions for **virtual laboratories**, namely tools CC developers can leverage to provide their designated community with working environments making it possible to experience with real services including cloud-based services.

While the set of tools discussed provides a robust foundation for addressing current needs, it is important to recognize that this list is neither complete nor exhaustive. As new challenges and requirements emerge, and as technology continues to evolve, additional tools and solutions will undoubtedly become necessary. Staying adaptable and open to innovation will ensure that Competence Centres remain equipped to meet future demands effectively.

Given the ever-evolving landscape, initiatives like Skills4EOSC are of paramount importance. By fostering a network of competence centres, these initiatives facilitate the exchange of experiences and solutions, enabling each centre to develop more rapidly than if they were working in isolation.

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