LTDP-TF Final Report & Recommendations

EOSC Association. Long Term Data Preservation Task Force
February 2024

EOSC Association AISBL
Rue du Luxembourg 3, BE-1000 Brussels, Belgium
+32 2 537 73 18 | info@eosc.eu | www.eosc.eu
Reg. number: 0755 723 931 | VAT number: BE0755 723 931

Table of contents

EOSC Association AISBL

Rue du Luxembourg 3, BE-1000 Brussels, Belgium
+32 2 537 73 18 | info@eosc.eu | www.eosc.eu
Reg. number: 0755 723 931 | VAT number: BE0755 723 931

Overview

This paper is a digest of and conclusion to the work of the EOSC Association's Long Term Data Preservation Task Force. The report provides an overview of the outputs produced, the vision for optimal preservation of FAIR Digital Objects within the context of EOSC, the conclusions from the task force and consultation process, and the final set of key recommendations.

Long Term Data Preservation Task Force outputs

These outputs are the result of frequent meetings and constructive working sessions between the task force members. Each document was shared with the wider community for consultation and feedback to be incorporated into the evolving documents. We thank all who have contributed to this work.

> Andreu, T., Anglada, L., Antos, D., Bähr, T., Brzeźniak, M., Burgi, P.-Y., Cavet, C., Celjak, D., Crépé-Renaudin, S., De Loof, C., Dillo, I., Dubois, O., Fernandes, R., Forsström, P.-L., Ganis, G., Gibney, E., Holl, A., L'Hours, H., Lamers, D., … Wyns, R. (2023). EOSC Preservation: Overview Discussion Paper. Zenodo. https://doi.org/10.5281/zenodo.7516259
>
> Andreu, T., Anglada, L., Antos, D., Bähr, T., Brzeźniak, M., Burgi, P.-Y., Cavet, C., Celjak, D., Crépé-Renaudin, S., De Loof, C., Dillo, I., Dubois, O., Fernandes, R., Forsström, P.-L., Ganis, G., Holl, A., Lamers, D., Lammert, A., L'Hours, H., … Wyns, R. (2023). Recommendations Consultation. EOSC-A Long Term Data Preservation Task Force. Zenodo. https://doi.org/10.5281/zenodo.10014698
>
> Anglada, L., Antos, D., Burgi, P.-Y., Cavet, C., Celjak, D., Dillo, I., Dubois, O., Fernandes, R., Lamers, D., L'Hours, H., Venkataraman, S., Viljoen, M., & Wyns, R. (2023). How a European network of FAIR-enabling Trustworthy Data Repositories can align to the vision of EOSC. Zenodo. https://doi.org/10.5281/zenodo.7568400
>
> L'Hours, H., & Wyns, R. (2023, December 1). Preservation in the context of EOSC. Sustainable repositories curating digital objects from a long term FAIR enabling perspective. https://doi.org/10.5281/zenodo.10020725

A Vision for Optimal Preservation of FAIR Digital Objects within EOSC

The LTDP-TF defined the following vision for optimal preservation of FAIR Digital Objects within the context of EOSC:

> Digital objects that act as inputs to, or outputs from, research are identified, findable and accessible in environments that support good storage practice. These objects are

EOSC Association AISBL
Rue du Luxembourg 3, BE-1000 Brussels, Belgium
+32 2 537 73 18 | info@eosc.eu | www.eosc.eu
Reg. number: 0755 723 931 | VAT number: BE0755 723 931

> subject to appraisal, and reappraisal over time, to assess their value, their impact and the associated costs, risks and benefits. Ongoing appraisal informs the level of investment in the retention, curation and active long-term preservation of digital objects. The levels of care, and changes to levels of care, provided by repositories and assigned to digital objects are transparent to their funders, depositors and users.

Achieving this vision is at the core of the task force's recommendations.

Conclusions from the Task Force & Consultation Process

This final report from the EOSC Association's (EOSC-A) Long Term Data Preservation Task Force (LTDP-TF) partially reiterates, but does not replace prior papers that provided an overview of the task force context[1], and input to how a European network of FAIR-enabling Trustworthy Data Repositories can align to the vision of EOSC[2].

The Task Force work on the Multi-Annual Roadmap[3] and input to the Strategic Research and Innovation Agendas[4] has resulted in the related funding calls 'Enabling an operational, open and FAIR EOSC ecosystem (2024)'[5] from the Horizon Europe Framework Programme. The calls addressing preservation infrastructure[6] and a network of trustworthy repositories[7] should address many of the issues raised by the LTDP TF.

There is an uneven distribution of awareness that preservation requires a long term commitment to data management that must adjust to changing technologies and the changing needs of users. The task force assesses that increased investment and ongoing action will be required at global, European, national, and institutional level beyond the scope and time frame of current calls and projects, to ensure that digital objects[8] remain understandable and usable to their community of users over time.

---

[1] EOSC Preservation: Overview Discussion Paper. https://doi.org/10.5281/zenodo.7516259

[2] How a European network of FAIR-enabling Trustworthy Data Repositories can align to the vision of EOSC. https://doi.org/10.5281/zenodo.7568400

[3] https://eosc.eu/sites/default/files/2023-01/MAR_2025-27_draft.pdf

[4] https://eosc.eu/sria-mar

[5] HORIZON-INFRA-2024-EOSC-01

[6] Long-term access and preservation infrastructure development for EOSC, including data quality aspects

[7] Enabling a network of EOSC federated and trustworthy repositories and enhancing the framework of generic and discipline specific services for data and other research digital objects

[8] As noted in the Overview paper: "'Digital objects' are not limited to 'research data', they extend to include metadata, software, semantic artefacts, publications, metadata related to physical samples, standards and schemas, in fact any digital objects that are of ongoing importance to researchers (and by extension to funders, policy makers and the public at large)".

EOSC Association AISBL
Rue du Luxembourg 3, BE-1000 Brussels, Belgium
+32 2 537 73 18 | info@eosc.eu | www.eosc.eu
Reg. number: 0755 723 931 | VAT number: BE0755 723 931

This report is accompanied by a revised version of the preservation assertions and recommendations document[9] which has been updated in response to community feedback. Preservation depends upon much of the same knowledge, skill and technology that are necessary to retain, store, and provide access to digital objects, but 'active' preservation[10] goes further. To provide active preservation for the long term, a repository must identify the need for actions, and then take the correct actions, to ensure that digital objects remain understandable and usable to their community of users. This requires the monitoring of communities' knowledge base and technology use, as well as the wider technical environment that digital objects depend upon. These changes over time, which occur beyond the boundary of the digital object, are the reason that initial curation steps at the point of deposit are not, alone, sufficient to ensure a digital object will remain understandable and usable for the long term.

The LTDP Task Force focuses on the need for active preservation as a level of care for digital objects that goes beyond their retention and initial curation. Active preservation may not be deemed necessary for all digital objects, but an appraisal process should define the level of care (retention, initial curation and preservation) to be applied. A repository should demonstrate that it is capable of providing, and be transparent about any change to, that level of care. Repository transparency increases the trust of users and funders and supports the evaluation and improvement of services and the outcomes of research.

An unknown number of digital objects remain unidentified and outside the scope of information management. Any organisational entity that holds digital objects at some point in the lifecycle is conceptually a repository. The overall number of repositories is unknown, and their definitions remain broad and unclear. Some definitions of trustworthy digital repositories (TDR) now include those that do not provide active preservation. The different levels of care are not clearly specified or communicated at either the repository or the object level. Understanding of the benefits, roles, actions and costs of digital object management, including active preservation, is limited. The FAIR Principles[11] remain an essential reference point, but they lack a temporal dimension to account for changes in preservation requirements over time. Digital object management practice remains divergent at the generic level and across disciplines and domains. The overall picture is far from entirely negative, but awareness of these risks is essential to planning for improved digital preservation capability.

Investment, cooperation and alignment between stakeholders is necessary to achieve a federated research landscape. Investment targets include the complex relationships between

[9] LTDP-TF Recommendations & Assertions. 10.5281/zenodo.10014697

[10] Levels A and B in the CoreTrustSeal Curation and Preservation Levels discussion paper equate to Active Preservation.

[11] Wilkinson, M., Dumontier, M., Aalbersberg, I. et al. The FAIR Guiding Principles for scientific data management and stewardship. Sci Data 3, 160018 (2016). https://doi.org/10.1038/sdata.2016.18

EOSC Association AISBL
Rue du Luxembourg 3, BE-1000 Brussels, Belgium
+32 2 537 73 18 | info@eosc.eu | www.eosc.eu
Reg. number: 0755 723 931 | VAT number: BE0755 723 931

people, organisations, processes and technologies that deliver infrastructure. Some specialised actors and services with the required knowledge and capabilities are either being specified, or already exist, but they remain unevenly distributed. Action must be taken to leverage these areas of good practice for wider benefit, while avoiding duplication of effort and unnecessary divergence of practice. Meeting this challenge requires consolidated and federated networks of service providers and trustworthy repositories on the European, national, and institutional level acting as centres of excellence. A balance is required between providing standardised activities and functions while allowing for the emergence of specialist practice at the disciplinary and domain level.

Trustworthy repository standards[12][13], including the CoreTrustSeal[14] define a set of requirements that are subject to community revision. They constitute a common reference point, even for repositories that do not address reusability or active preservation. Efforts to define the specialised needs of different geographies, domains and digital object types, should be mapped to CoreTrustSeal to enable alignment without restricting the development of new criteria. Evaluation processes, including certification, are valid and useful. However, the primary goal of assessing repositories and objects should be the identification of current capability to enable assistance and improvement.

Standards development, assessment, assistance and improvement all depend on transparency of practice. Negative outcomes of evaluations may reduce the desire to be transparent. This is why no unjustified gatekeeping of participation in or access to services, including EOSC, should take place if it risks excluding potentially high-quality services or high-value digital objects from research infrastructures. Digital objects and the services that enable their FAIRness, deposit, storage, curation, access and preservation require targeted investment to meet the costs of transparency, particularly through an increased quality and quantity of repository and object level metadata.

Clarity on the permissions, prohibitions and obligations that apply to different human actors and machine agents is essential to trust. Transparency of responsibility is also essential to machine-actionable rights management at scale.

Preservation aims to generate assets for research with long term value. Therefore, digital objects must be retained, stored, findable, accessible, interoperable and reusable over time. Deciding which digital object should, and which should not, be preserved must be done via transparent appraisal processes, any change to levels of care (after periodic reappraisal) must also be transparent and justified. This includes criteria set at the point of deposit in a

[12] ISO16363 Audit & Certification of Trustworthy Repositories https://public.ccsds.org/Pubs/652x0m1.pdf
[13] DIN31644 Nestor Seal for Trustworthy Digital Archives https://www.langzeitarchivierung.de/Webs/nestor/EN/Zertifizierung/nestor_Siegel/siegel.html
[14] https://www.coretrustseal.org/why-certification/requirements/

EOSC Association AISBL
Rue du Luxembourg 3, BE-1000 Brussels, Belgium
+32 2 537 73 18 | info@eosc.eu | www.eosc.eu
Reg. number: 0755 723 931 | VAT number: BE0755 723 931

repository, initial curation actions, and measures to ensure long term preservation. Transparency goes beyond specific actions taken on specific objects and includes measures to monitor changes to the technical landscape and the needs of digital objects' reusers. Classified and aligned standards, practices, policies and training materials are all candidates for inclusion in future registries of reference information for repositories. Creating and curating digital objects with a view to their long term usability through preservation actions should be embedded in education and professional development training.

Trustworthy Digital Repository standards focus on the organisational infrastructure, digital object management, and technical and security aspects of organisations providing active preservation. However, many of these criteria are equally relevant to ensuring the sustainability and effectiveness of all organisations and services required to deliver modern, federated research infrastructures. The balance of effort and investment must include consideration of the roles, skills and processes undertaken by people, as well as the technologies required to manage the digital bits of objects.

The functions of software and services from commercial and non-commercial providers must be clearly described so they can be assessed, compared and procured, and their operational effectiveness assured. The technical side of these considerations is provided through work such as the DPC Procurement Toolkit, whose 'core requirements for a digital preservation system'[15] include technical infrastructure for storage and access but goes beyond these to address measures taken at the point of deposit[16] and from a longer term preservation perspective[17]. The clearer definition and separation of activities and functions related to basic retention and initial curation from those required for active longer term care will be necessary to identify the true additional costs, including environmental costs, of active preservation. Understanding these costs will enable targeted investment into active preservation where necessary and the selection of alternative levels of care for other scenarios.

Important work related to preservation has been done, is ongoing, and will be undertaken , including through projects funded by current calls. Maintaining a focus on preservation within provides assurances that the long term value of digital objects as research assets will be maintained. Achieving a functional EOSC requires an active exchange forum to enable alignment and to mitigate duplications of effort on the subjects of preservation, repositories, levels of care, different types of data service and a range of digital object types. Any future

[15] https://www.dpconline.org/docs/digital-preservation/procurement-toolkit/2581-core-requirements-for-a-digital-preservation-system-v1/file

[16] "5. The system must have the facility to assess the characteristics of ingested digital content and record them in associated metadata".

[17] "7. The system should support preservation planning, including risk assessment, and the design and testing of plans to preserve digital content." "8. The system should enable preservation actions that fulfil preservation plans designed to mitigate identified preservation risks".

EOSC Association AISBL
Rue du Luxembourg 3, BE-1000 Brussels, Belgium
+32 2 537 73 18 | info@eosc.eu | www.eosc.eu
Reg. number: 0755 723 931 | VAT number: BE0755 723 931

focus on preservation in the context of EOSC should include connection points to digital objects' curation, criteria to ensure organisational viability, and to the specification, procurement and financing of infrastructure.

Recommendations

The sections below present the final recommendations of the task force as extracted from the full set of numbered assertions and recommendations provided in the consultation paper[18]. Each recommendation is followed by an @ symbol and its numeric identifier from the consultation paper. Most of the recommendations apply to the wider data repository landscape and associated stakeholders on a global, European, national, institutional (including universities), and thematic (domain, discipline) level. Those recommendations that are specific to a certain context are headed accordingly. If a recommendation suggests that something needs to be 'defined' then the implied follow up actions are 'adopted' and 'made transparent'.

Recommendations that were marked as priorities by those providing feedback during the consultation are presented in bold and marked with an asterisk*.

Repositories and the Digital Object Lifecycle

Desirable characteristics of digital objects, including FAIR, at the point of re-use depend on a range of storage, curation, preservation and appraisal activities undertaken by different data and metadata services, including repositories, throughout the lifecycle. These outcomes depend on clear criteria, transparency and a long-term perspective.

> Additional work is needed to define different types of digital object systems that offer data and metadata services, including the activities and functions they require and the levels of care they provide for data and metadata (@14).
>
> Minimum criteria for acceptable storage practices should be defined as a foundation for all levels of retention, curation and preservation services (@16).

Curation & Preservation: Levels of Care

Given the lack of granular definitions in place to differentiate (trustworthy) repositories, registries and other data and metadata services, the task force engaged with the CoreTrustSeal discussion of Curation and Preservation Levels. The revised version[19] of that paper, including revisions based on task force feedback, differentiates between unattended

[18] Recommendations Consultation. EOSC-A Long Term Data Preservation Task Force. Zenodo. https://doi.org/10.5281/zenodo.10014698

[19] CoreTrustSeal Standards and Certification Board. (2023). Curation & Preservation Levels: CoreTrustSeal Discussion Paper (v02.00). Zenodo. https://doi.org/10.5281/zenodo.8083359

EOSC Association AISBL
Rue du Luxembourg 3, BE-1000 Brussels, Belgium
+32 2 537 73 18 | info@eosc.eu | www.eosc.eu
Reg. number: 0755 723 931 | VAT number: BE0755 723 931

deposit-storage-access services where content is distributed as deposited (level Zero), services that set compliance criteria at the point of deposit (Level D), services that provide initial curation at the point of deposit to achieve defined compliance criteria (Level C). These are followed by levels of service that provide active preservation of desirable digital object characteristics over time through technical measures (Level B-Logical Technical) and measures that ensure that objects remain understandable and reusable (Level A). The Task Force recommends that these levels form the basis for future definitions of data and metadata services for all types of digital object.

> Repositories should specify all the levels of care they apply to objects within their collection, including through repository and digital object registry metadata (@19).
>
> **Digital objects should include metadata that specify their level of care and the timeframes or criteria for reappraisal of the level of care*** (@20).

FAIR + Time

As time passes, technologies and the needs of digital object (re)users evolve. This may result in digital objects becoming less FAIR over time. Transparent FAIR-enabling repositories are required to monitor the situation and take additional FAIR-enabling preservation actions over time as necessary.

> FAIR-enabling practices to be undertaken by all repositories should be defined (@23).
>
> **FAIR-enabling practices undertaken by repositories should be made transparent to users and funders to increase trust in services*** (@23).

Preservation Systems, Actions & Outcomes

To achieve preservation outcomes (long-term access to and use of digital objects that maintain desirable characteristics, including FAIRness) we depend on sustainable preservation systems (organisations, partnerships or other entities) that take responsibility for monitoring the technical and user environments and, where necessary, take preservation actions on digital objects (data and/or metadata).

A key issue for the task force was that the functions and activities required to deliver active long term preservation significantly overlap with those required for storage, retention and initial curation. This makes it challenging to differentiate the unique roles and costs associated with active long term preservation.

> Unique preservation activities and functions should be defined alongside activities and functions that apply to all repositories (@29).

EOSC Association AISBL
Rue du Luxembourg 3, BE-1000 Brussels, Belgium
+32 2 537 73 18 | info@eosc.eu | www.eosc.eu
Reg. number: 0755 723 931 | VAT number: BE0755 723 931

Trustworthy Digital Repositories (TDR) and other (meta)data Services

Trustworthy Digital Repositories (TDR) comply with a set of organisational infrastructures, digital object management, technology and security requirements. TDR standards, such as the CoreTrustSeal, currently require that repositories provide active preservation (Levels B and A, see the section Curation & Preservation levels above) to ensure ongoing re-use of digital objects. But many of the TDR requirements, including CoreTrustSeal, are applicable to a broader range of repositories and data services. Certification in general, and CoreTrustSeal in particular, are not always the appropriate solution, but the CoreTrustSeal requirements and revision consultation approach provide a common reference point that other criteria for repositories and data services can usefully align with. As noted in the consultation paper "the CoreTrustSeal is a not-for-profit foundation, developed in response to an RDA[20] mission and maintained through the RDA, that provides 16 Requirements and an associated peer review and certification process for TDRs" and "The LTDP TF reasserts the conclusion of previous EOSC-relevant papers and groups that the CoreTrustSeal provides an appropriate mechanism to define core expectations of TDRs and an exemplar for offering assessment and certification services".

> Other ongoing work to define repository and data service characteristics and expectations exist and should be encouraged and supported[21] (@34).
>
> **To maintain clarity and alignment these other efforts should map and crosswalk their own criteria to the CoreTrustSeal. Any reductions, additions or variations versus the CoreTrustSeal should be documented and explained to support interoperability of standards and approaches*** (@35).
>
> **Efforts to define more specific domain/disciplinary criteria, or criteria that define expectations for specific types of digital objects should adopt the CoreTrustSeal requirements where possible, and elaborate on them where necessary*** (@38).
>
> **Additional work is needed to define different types of digital object systems, the activities and functions they undertake, and the levels of care they provide for data and metadata*** (@39).
>
> **Roles and responsibilities including for complex partnerships, third party relationships and outsourcing should be understood and transparent*** (@40).

[20] https://rd-alliance.org/

[21] Repository & (meta)data Services Functions & Activities: Crosswalk https://doi.org/10.5281/zenodo.7690658

EOSC Association AISBL
Rue du Luxembourg 3, BE-1000 Brussels, Belgium
+32 2 537 73 18 | info@eosc.eu | www.eosc.eu
Reg. number: 0755 723 931 | VAT number: BE0755 723 931

Technical repository service providers' (storage providers, ARCHIVER[22] etc) portfolio of service offerings should be clear and comparable for client end-users[23]* (@41).

Standards, Assessment, Certification & Alignment

Defining standards for objects and repositories supports a common understanding of characteristics and goals. Assessment permits benchmarking of current status and planning for future improvements. Certification is one possible outcome of assessment to acknowledge good practice. Alignment of standards and assessment processes is an effective mechanism for agreeing on desirable outcomes and providing guidance and support.

Standards and guidance should be developed, coordinated and maintained to provide full lifecycle information on preservation to researchers and preservation practitioners (@48).

Outcomes, Judgement and Gatekeeping

Digital objects and repositories at all levels of maturity are on a journey towards FAIR and trustworthiness. Transparency of practice and assessments should be used as a tool for developing roadmaps on a journey of improvement. Exclusionary judgements and gatekeeping (e.g. inclusion in the EOSC) based on assessment results should be avoided in favour of investment and assistance.

Digital Objects and the services that enable their FAIRness, deposit, storage, curation, access and preservation should be supported in transparent efforts to use assessment as a route to assistance and improvement* (@53).

Efforts by repositories and other data services to share transparent information about their functions, activities and objects should be rewarded by targeted investment for improvement* (@54).

No repository or digital object should be unnecessarily excluded from any part of EOSC (@55).

FAIRness and trustworthiness must continue to be a supported journey for all parties* (@56).

Retention, Appraisal & Re-Appraisal

Any activities that retain, identify and evaluate a greater proportion of relevant digital objects are desirable. Some of these objects may be appraised as having sufficient value to be

[22] https://archiver-project.eu/

[23] E.g. via efforts such as https://www.rd-alliance.org/rda-tiger

EOSC Association AISBL
Rue du Luxembourg 3, BE-1000 Brussels, Belgium
+32 2 537 73 18 | info@eosc.eu | www.eosc.eu
Reg. number: 0755 723 931 | VAT number: BE0755 723 931

retained, curated or actively preserved. Reappraisal over time may change the level of care received by a digital object, or lead to a decision to delete the object. Like curation and preservation, appraisal and reappraisal depend on appropriate expertise. Levels of care, and changes to levels of care should be justified and transparent.

> Retention and reappraisal decisions and timescales, including guaranteed preservation timescales, should be transparent (@61).

Transparency of Services, Artefacts and Levels of Care for Objects

Exposing the different levels of service offered, and the levels of care received by objects, along with the evidence artefacts that support these assertions provides a level of transparency that informs understanding, cooperation and interoperability between the many actors and objects across the research data lifecycle.

> **Each repository should be transparent about the levels of care provided*** (@65).
>
> **Each object should have a clear level of care associated with the repositories that take responsibility for them*** (@66).
>
> Living and machine-actionable data management plans should form the basis of continuity through the research data lifecycle (@67).
>
> **Registries of repositories and other data services should align metadata about levels of care and supporting information*** (@68).
>
> Registries of digital objects should align metadata relating to retention periods, appraisal periods and levels of curation and preservation (@69).

Generic versus Domain, Discipline and Object Type Specific Issues

All of the assertions and recommendations above, and the roles and actors described below are specified at a high level due to the scope and timescales of the task force. Further exploration of the specific needs implied by discipline, domain and object type is required.

> Addressing the challenges of digital object interoperability in and across scientific domains and disciplines must be supported by further investment to identify granular needs for specific types of digital objects and disciplines (@70).

Roles and Responsibilities

Roles and responsibilities across partners and the lifecycle are not always well defined and many of them (e.g. those involving storage or initial curation) are important but not sufficient for preservation. Clarity on roles informs the need for specialist skills (e.g. disciplinary or by

EOSC Association AISBL
Rue du Luxembourg 3, BE-1000 Brussels, Belgium
+32 2 537 73 18 | info@eosc.eu | www.eosc.eu
Reg. number: 0755 723 931 | VAT number: BE0755 723 931

digital object type). Clear responsibility is of particular importance when defining workflows within and between organisations. Organisational cooperation and interoperability depend on rights management agreements that are ultimately built on the roles and responsibilities around digital objects.

Where responsibility is distributed, accountability should remain clear, including for digital objects' loss or destruction (@75).

Digital object management outcomes, including preservation, should be integrated into a roles and responsibilities framework that integrates all actors and actions (@77).

The roles and responsibilities framework should be aligned with clear process models that meet the needs of different stakeholder communities (@78).

From the point of conception of a digital object defined roles and responsibilities should be in place to ensure that preservation actions are considered throughout the lifecycle (@81).

Risk analysis approaches should be used to identify when in the lifecycle it is appropriate to take preservation actions. This includes the availability of individual researcher expertise about the digital objects (during the conception/collection/creation phase) versus the broader expertise and opportunities for economies of scale during the repository phase (@83).

Different roles should use a living data management plan as a key artefact for periodic audit, review and revision (@84).

Policy makers[24] must make the development and implementation of active preservation explicit in policies applicable to all stakeholders and across the lifecycle. They are accountable for periodic review and revision of policy* (@85).

Executives must adopt a preservation policy into their operational and strategic planning (@86).

Managers must integrate preservation planning into operational management including staffing, funding, service development and procurement (@87).

Practitioners must provide guidance, community and technology monitoring and, where necessary, take preservation actions to ensure optimal preservation outcomes (@88).

[24] FAIR Forever Use Case 5, A mechanism for digital preservation policy across institutions within EOSC, would offer valuable resources to help research policy makers with these responsibilities.

EOSC Association AISBL
Rue du Luxembourg 3, BE-1000 Brussels, Belgium
+32 2 537 73 18 | info@eosc.eu | www.eosc.eu
Reg. number: 0755 723 931 | VAT number: BE0755 723 931

Digital objects' creators, collectors and reusers, including researchers, should develop the knowledge and skills at a general level and within their own disciplinary and domain area of expertise, so that their actions early in the lifecycle enable preservation* (@90)

All of the preservation-specific and supporting research data management roles across the data lifecycle require sustained training* (@91).

Clear responsibilities must be in place for developing standards and guidance for communication and for training (@92).

Finance & Funders

Further research and analysis are necessary to support business planning based on qualitative and quantitative risks and benefits[25] (@95).

Funders should clarify to all grant holders that the FAIR Principles and the potential need for preservation are full lifecycle issues (@96).

Funders should integrate into their calls the costs required to meet the needs for compliance with the FAIR Principles and any long-term preservation* (@97).

Audit pathways are essential for all research outputs (@99).

Data management plans should define obligations and support accountability (@100).

Once identified, critically endangered content that retains value requires investment (@101).

Full lifecycle costs should be assessed, including the unique costs of preservation using methodologies that include the potential costs of inaction (@102).

Identify and support sustainable staffing costs for preservation-specific roles and responsibilities* (@103).

Network of TDRs

Current and future networks of preservation practitioners, including TDRs, can support the development, evaluation, implementation and monitoring of all the recommendations made in this paper and provide a platform for* (@108):

[25] FairForever Use Case A business case factory or service for preservation cost modelling.

EOSC Association AISBL
Rue du Luxembourg 3, BE-1000 Brussels, Belgium
+32 2 537 73 18 | info@eosc.eu | www.eosc.eu
Reg. number: 0755 723 931 | VAT number: BE0755 723 931

a. Networking and knowledge exchange[26], improving FAIR-enabling capabilities and trustworthiness.
b. Stakeholder advocacy and engagement[27], acting as a "unified voice" of the repository community.
c. Aligning with and providing input to the EOSC ecosystem, including repository landscape monitoring and defining the requirements of repositories and their users.
d. Coordination and development of frameworks for research data repository policies and routines[28], such as a strategic framework to achieve baseline certification, to audit data management plans[29], and to identify preservation pathways for data[30].
e. Evaluation of FAIR metrics and tools and provision of feedback on efforts to align certification requirements with FAIR[31].
f. Identification of costs of action versus inaction with respect to high value, critically endangered content[32].

Addressing Preservation at European, National and Institutional Level

Greater clarity is needed in the EOSC vision for the application of preservation activity across the lifecycle and at EU, National and institutional level* (@109).

Recommendations at European Level

European level influence may act directly on institutions or via the subsequent actions of national level policies and practices. In all cases actions should be aligned at the relevant European, National or Institutional Level. EOSC cannot achieve its goals in the long-term unless

[26] Towards a European network of FAIR-enabling Trustworthy Digital Repositories (TDRs) - A Working Paper https://doi.org/10.5281/zenodo.7034315
[27] https://doi.org/10.5281/zenodo.7034315
[28] https://doi.org/10.5281/zenodo.7034315
[29] (FF10) "Provide strategic framework for audit of data management plans Adapt workplans to include quality improvement mechanisms where these do not already exist, including DPC Rapid Assessment Model, establishing thereby a strategic framework to achieve baseline certification for primary preservation services, or identifying preservation pathways for data".
[30] (FF04) "Adapt workplans to include quality improvement mechanisms where these do not already exist, including DPC Rapid Assessment Model, establishing thereby a strategic framework to achieve baseline certification for primary preservation services, or identifying preservation pathways for data".
[31] How a European network of FAIR-enabling Trustworthy Data Repositories can align to the vision of EOSC https://doi.org/10.5281/zenodo.7568400
[32] (FF14) "Identify costs of action versus inaction with respect to high value, critically endangered content".

EOSC Association AISBL
Rue du Luxembourg 3, BE-1000 Brussels, Belgium
+32 2 537 73 18 | info@eosc.eu | www.eosc.eu
Reg. number: 0755 723 931 | VAT number: BE0755 723 931

preservation is addressed. Preservation is critical to EOSC digital objects, reputation and sustainability.

Digital preservation risks and opportunities must be made explicit in the EOSC vision and monitored and addressed as the EOSC evolves (@111).

"EOSC cannot rely on a single generic canon of 'digital preservation practice'. Instead, workflows should leverage large scale infrastructures while remaining faithful to discipline-specific requirements" (@112).

Roles, responsibilities, and accountabilities for preservation in EOSC should be clarified (@113).

EOSC should establish a workplan for policy development and implementation within EOSC services and partners including delivery or support of (@114):

a. A dedicated preservation group with an EOSC Board member providing communication and liaison.
b. A high-level digital preservation policy across EOSC with defined connection points to national and institutional preservation policies.
c. The monitoring of policy implementation across EOSC partners.
d. A definition of objectives, challenges, and implications for the preservation of digital objects.
e. A point of contact between EOSC and other digital preservation communities within and beyond the research data community.

Support the alignment between the interpretations of FAIR for digital objects and the criteria for data and metadata services, including repositories, to be FAIR-enabling at whatever level of care they provide* (@115).

Establish pathways for continuous quality improvement that reflect* (@116):

a. The wide range of digital objects and repositories striving to engage with EOSC.
b. The scenarios where standards compliance and assessment are necessary achievements rather than desirable targets e.g. for the protection of sensitive data.

Support the development of verified business models for repositories, including preservation services[33] (@117).

[33] Cf: FAIR Forever Use Case 3: A Business Case Factory or Service for Preservation Cost Modelling within EOSC.

EOSC Association AISBL
Rue du Luxembourg 3, BE-1000 Brussels, Belgium
+32 2 537 73 18 | info@eosc.eu | www.eosc.eu
Reg. number: 0755 723 931 | VAT number: BE0755 723 931

Support the development of digital rights management standards and mechanisms that enable the transition of digital objects and repositories' licences towards machine-actionable, scalable interoperability including (@118):

a. Granular and dynamic digital objects.
b. Complex organisational partnerships and outsourcing.
c. Full lifecycle research data management, storage, curation and preservation.

Recommendations at National Level

Actions taken at European level should be adopted, adapted for national needs, and support provided for implementation (@119).

When actions cannot be taken at European level they should be developed and implemented at national level (@120).

Recommendations at Institutional Level

Support researchers in digital object design, creation, storage, curation and preservation whether through locally provided repositories or via third parties* (@121).

Take appropriate responsibility for relevant phases of the research data lifecycle including assurances that digital objects are made FAIR and that services are FAIR-enabling and trustworthy* (@122).

Support ongoing review and audit of infrastructure and practice across the lifecycle (@123).

Funders should commission repositories to conduct audits, and repositories should undertake these audits (@124).

EOSC Association AISBL
Rue du Luxembourg 3, BE-1000 Brussels, Belgium
+32 2 537 73 18 | info@eosc.eu | www.eosc.eu
Reg. number: 0755 723 931 | VAT number: BE0755 723 931