



FAIRSFair
Fostering Fair Data Practices in Europe

Project Title	Fostering FAIR Data Practices in Europe
Project Acronym	FAIRsFAIR
Grant Agreement No	831558
Instrument	H2020-INFRAEOSC-2018-4
Topic	INFRAEOSC-05-2018-2019 Support to the EOSC Governance
Start Date of Project	1st March 2019
Duration of Project	36 months
Project Website	www.fairsfair.eu

D2.7 Framework for assessing FAIR Services

Work Package	WP2 - D2.7 Framework for assessing FAIR Services
Lead Author (Org)	Sara Ramezani (SURF)
Contributing Author(s) (Org)	Tero Aalto (CSC), Morane Gruenpeter (INRIA - Software Heritage), Patricia Herterich (DCC, University of Edinburgh), Rob Hooft (DTL), Hylke Koers (SURF)
Due Date	31.08.2021
Date	27.08.2021
Version	1.0 DRAFT NOT YET APPROVED BY THE EUROPEAN COMMISSION
DOI	https://doi.org/10.5281/zenodo.5336233

Dissemination Level

<input checked="" type="checkbox"/>	PU: Public
<input type="checkbox"/>	PP: Restricted to other programme participants (including the Commission)
<input type="checkbox"/>	RE: Restricted to a group specified by the consortium (including the Commission)
<input type="checkbox"/>	CO: Confidential, only for members of the consortium (including the Commission)

Abstract

In this work we present the FAIRsFAIR service assessment framework, a framework for assessing how well research data infrastructure services support FAIR data. The framework focuses on providing guidelines on how services can be made to optimally improve the FAIRness of the data that they are used for. This work was inspired by a combination of literature describing the expectations users have from FAIR data services, and refined by the authors based on feedback from the community gained e.g. through workshops. This framework is the last deliverable of the T2.4 task group in the FAIRsFAIR project, and it will be presented to the European Open Science Cloud (EOSC) where we expect the most direct usage of the framework.

Versioning and contribution history

Version	Date	Authors	Notes
0.1	07.06.2021		First draft
0.8	16.07.2021	Sara Ramezani (SURF), Tero Aalto (CSC), Morane Gruenpeter (INRIA - Software Heritage), Patricia Herterich (DCC, University of Edinburgh), Rob Hooft (DTL), Hylke Koers (SURF)	Draft for internal review
0.9	17.08.2021	Tina Dohna (Universität Bremen), Chris Ariyo (CSC)	Version with review comments
1.0	27.08.2021	Sara Ramezani (SURF), Tero Aalto (CSC), Morane Gruenpeter (INRIA - Software Heritage), Patricia Herterich (DCC, University of Edinburgh), Rob Hooft (DTL), Hylke Koers (SURF)	Final version

Disclaimer

FAIRsFAIR has received funding from the European Commission's Horizon 2020 research and innovation programme under the Grant Agreement no. 831558. The content of this document does not represent the opinion of the European Commission, and the European Commission is not responsible for any use that might be made of such content.

Abbreviations and Acronyms

AAI	Authentication and Authorisation Infrastructure
API	Application Programming Interface
EOSC	European Open Science Cloud
FAIR	Findable, Accessible, Interoperable, Reusable
GDPR	General Data Protection Regulation
HTTP	Hypertext Transfer Protocol
OLA	Operational-Level Agreement
PID	Persistent Identifier
SLA	Service-Level Agreement

Executive Summary

Research data infrastructure services can be of great help to researchers who are applying FAIR research data management practices. The FAIRsFAIR service assessment framework presented in this work provides assistance to the providers of such data services: it helps them to find out how they can improve their services. The framework was inspired by a combination of literature describing the expectations users have from FAIR data services, and refined by the authors based on feedback from the community gained e.g. through workshops.

The framework is **not** meant to describe aspects of the “FAIRness of services”, but instead focuses on *how services can be made to optimally improve the FAIRness of the data that they are used for*. The recommendations in the framework are presented in seven blocks of either technical or social recommendations: Actual FAIR Enablement (how the FAIRness of the data is directly affected by the service) is one of these, the others are Quality of Service, Open & Connected, User Centricity, Transparency, Longevity, and Ethical & Legal. Each of the recommendations in these blocks (between 4 and 11 per block, 50 in total) have been given a priority to indicate where most value for users of the services can be found; 22 of the recommendations have an *essential* priority.

The presented framework only contains recommendations that are applicable to the full variety of data services, it explicitly does *not* contain recommendations suitable only to a subclass of data services.

This Framework is the last deliverable of a task group in the FAIRsFAIR project, and it will be presented to the European Open Science Cloud (EOSC) where we expect the most direct usage of the framework. We also expect that future refinement of the framework will take place under the responsibility and/or guidance of the EOSC association.

Table of contents

Executive Summary	4
Table of contents	5
1. Introduction	6
2. Development of versions	6
3. FAIRsFAIR service assessment framework	8
Aspect: SAF-F FAIR enablement	8
Aspect: SAF-Q Quality of service	9
Aspect: SAF-O Open & Connected	11
Socially-oriented aspects	12
Aspect: SAF-U User centricity	12
Aspect: SAF-T Transparency	13
Aspect: SAF-L Longevity	14
Aspect: SAF-E Ethical & Legal	15
4. Conclusion	16
5. References	18

1. Introduction

In this task we have taken a look at how and to what extent the FAIR principles can be applicable to services that enable and support FAIR data. The FAIR principles (Wilkinson et al., 2016) have been devised as a standard for managing research data, thus extending the ideas to services has required careful considerations of what each of these principles means in this context.

As a working definition, we have considered a ‘data service’ any service that acts on at least one component of the ‘trinity of data management’: the bit sequence, the metadata, and the PID of a digital object¹. This includes services that bind these components together (e.g. associating metadata with a bit sequence), services that deliver data to the user, services that automatically analyze or transform data, services that aggregate and index metadata, services that store or replicate data, etc². Stakeholders from a number of these services were interviewed to shape the framework and invited to follow-up during the consultation sessions, see (ADD CITATION) for an analysis of their viewpoints. (Koers et al., 2020), Data services are an essential component in a FAIR ecosystem, yet there is limited tangible guidance on how to “make services support FAIR”. Looking at the FAIR principles from the lens of services, it seemed much more useful to look at how a service acts on the data that it operates on rather than how FAIR the service *is*: rather than applying each of the FAIR principles on the service itself, these can be applied on the data that it operates on, and the consequence for the service then operationalized.

The result of the operationalization of FAIR for data services is presented in this work in the form of a framework of recommendations. These are written not for policy makers to evaluate services, but for service providers who are looking for the best way to improve their offering in a FAIR data ecosystem like the European Open Science Cloud.

2. Development of versions

Developing the FAIR assessment framework for services followed a very iterative process. An initial version of the framework was presented in M2.10 Report on basic framework on FAIRness of services (Koers et al., 2020) based on extensive literature review (referenced again in the bibliography for completeness), interviews with service owners covering a wide range of data services and input gathered at a session at the EOSC-hub week in May 2020. The initial framework consisted of six aspects: three social aspects (User centricity, Ethical & Legal, Trustworthiness), and three technical aspects (FAIR enabling, Quality of service, Open & Connected). Each aspect was clarified with an objective and several recommendations that service owners can follow to ensure their data services are ‘FAIR enabling’.

¹ A digital object (DO) is defined as a set of bits, or a set of sequences of bits, incorporating a work or portion of a work or other information in which a party has rights or interests, or in which there is value (“Digital Object Architecture | DONA Foundation,” n.d.)

² A more formal description of data services — e.g. a classification or a taxonomy — was deemed as out of scope for this task. Our discussions highlighted that such a formal description of services would be useful and support applying the framework in a range of use cases going forward.

To ensure the framework is seen as fit for purpose by the community, we hosted a workshop to gather detailed feedback in February 2021. The workshop was open to everyone – participants were providers of data services and other interested stakeholders, covering a wide range of scientific disciplines. During the workshop, the six key aspects of the framework were discussed and analyzed in detailed breakout sessions to identify gaps and formulate improvements. All notes and input collected in the three-hour workshop are available in (Koers et al., 2021a). Following the workshop, we created an updated version of the assessment framework (version 2) with changes covering minor rephrasing to clarify some recommendations, additions and deletions of recommendations and re-ordering of recommendations to reflect the priorities expressed by the attendees of the workshop breakout sessions.

Iteration 2 was discussed internally within FAIRsFAIR, taking advantage of the collaborative sessions at the FAIRsFAIR week 2021³ in April 2021 to ensure that our work aligns with other project activities, especially the work around the maturity of data repositories carried out in T4.1. The resulting iteration 3 was made available in May 2021 (Koers et al., 2021b) and introduced an update to the aspect classification, splitting Trustworthiness into Transparency and Longevity. Additional changes covered rewording of some recommendations as well as deletions of duplicate recommendations. We also clarified the term FAIR-enablement by highlighting that it can involve both augmenting the FAIRness of a digital object and facilitating a certain FAIR principle.

Iteration 3 was again validated in a workshop with service owners and other interested stakeholders in May 2021. The session focused on getting feedback on the following questions for each aspect:

1. Is this objective/recommendation relevant for services in a FAIR ecosystem?
2. Should this recommendation be prioritized? Essential (high) E / highly recommended (medium) H / desired (low) L / redundant (not needed) R ?
3. Do you know services that already answer this specific recommendation?

All suggestions gathered in that workshop can be read up in detail in (Ramezani et al., 2021).

Following the validation workshop, iteration 4 was created. It consolidated and rephrased some recommendations where appropriate. We also introduced identifiers for the recommendations to allow for easy cross-referencing where the recommendations are linked. The identifier system follows the following logic:

SAF -	Q -	3
FAIRsFAIR service assessment framework	identifier for the aspect	number of the recommendation

In addition, we assigned each recommendation a priority: essential / important / useful with essential being the highest priority. Iteration 4 was made available for a last round of community-wide feedback in June 2021.

³ <https://www.fairsfair.eu/events/fairsfair-week-2021>

The current framework, presented in section 3, is the fifth iteration since the framework was first released in October 2020. This iteration results from incorporating feedback received during the June 2021 community consultation. Changes include introducing sub-points for some recommendations, SAF-L-3 and SAF-Q-5, highlighted by letter bullet points, as well as minor updates on language and style.

3. FAIRSFAR service assessment framework

The recommendations in this framework are presented in seven blocks of either technical or social aspects: Actual FAIR Enablement (how the FAIRness of the data is directly affected by the service) is one of these, the others are Quality of Service, Open & Connected, User Centricity, Transparency, Longevity, and Ethical & Legal. Each of the recommendations in these blocks (between 4 and 11 per block, 50 in total) have been given a priority to indicate where most value for users of the services can be found; 22 of the recommendations have an essential priority.

Technically-oriented aspects

Aspect: SAF-F FAIR enablement		
<p>Objective: The service enables FAIR data by elevating the FAIRness of digital objects and/or supporting the FAIRification process. FAIR enablement is actively driven through the implementation of community-supported standards and interoperability frameworks.</p> <p>The following classification defines the levels in which a service affects the FAIRness of data on which it operates.</p> <ul style="list-style-type: none"> • Enable: <ul style="list-style-type: none"> ○ Augment: The service provides elements improving FAIRness of the digital object — for example automatically assigning a PID; ○ Facilitate: The service actively helps to realize a particular FAIR principle — for example by allowing the user to add metadata or enabling discoverability; • Respect: The service neither actively enables a particular FAIR principle nor interferes with it — it can be said to respect the “FAIR-in-FAIR-out” principle; • Reduce: The service actually makes data less FAIR — at least for a particular principle — for example by detaching metadata or a PID when it acts on a digital object. 		
Identifier	Recommendation	Priority
SAF-F-1	In consultation with the target community (or communities), identify which metadata schemas and other standards (e.g. technical and semantic aspects of data encoding) should be adopted. Consider in particular domain-specific standards and practices. Strive to include accessibility conditions in the metadata. Where applicable, generate	Essential ☆☆☆

	and capture metadata automatically and be transparent about the concepts the service can provide an answer to.	
SAF-F-2	Engage with both the user community and other service providers to improve interoperability between services. Of particular attention here are authentication and authorization infrastructure (AAI), PIDs, and data and metadata encoding specifications. Seek alignment with existing or emerging data type registries and interoperability frameworks, e.g. the EOSC interoperability framework.	Essential ☆☆☆
SAF-F-3	Consider both human and machine access to the service, specifically with a view towards supporting automated pipelines for the FAIRification of digital objects.	Essential ☆☆☆
SAF-F-4	Use persistent identifiers to refer to data and metadata.	Essential ☆☆☆
SAF-F-5	Perform a self-assessment on how the functions of the service <i>enable, respect or reduce</i> each of the FAIR principles for the data it operates on ⁴ . Make the results of the self-assessment publicly available, together with an outlook on the desired state for the service (including a cost/benefit analysis) ⁵ .	Important ☆☆
SAF-F-6	Use automated tests that show how the service increments the FAIRness of digital objects in a verifiable, measurable, repeatable and scalable way. Root such tests in community-supported methodologies that measure the FAIRness of digital objects in an objective way.	Useful ☆

Aspect: SAF-Q Quality of service

Objective

The service is delivered in a reliable, secure, high-quality way, consistent with its specifications.

Identifier	Recommendation	Priority
------------	----------------	----------

⁴ The case studies presented in Ref. (3) offer a suggested format for this self-assessment. Of course, other formats are acceptable as well. However, we do recommend to include all of the aspects listed in the case studies (i.e. Summary, Users, Purpose, Adoption, Services, Target Digital Objects, Examples, FAIR enablement mapping).

⁵ Note that a service does not need to address all aspects of FAIR, and integration with other FAIR-enabling services (e.g. PID minting) is often preferable over developing one's own solutions.

SAF-Q-1	Deploy the service on appropriate and well-supported hardware or virtual (cloud) infrastructure. Define operational-level agreements (OLA) with 3rd-party infrastructure services that enable service delivery.	Essential ☆☆☆
SAF-Q-2	Take reasonable technical and non-technical measures to prevent, detect, and respond to cyber or physical security threats, securing the service and protecting sensitive information resources (e.g. only using secure HTTP connections). Organize security audits and penetration tests at regular intervals, ideally at least every two years.	Essential ☆☆☆
SAF-Q-3	Assess whether the service deals with sensitive data (e.g. patient records) and, if so, take additional measures in line with both applicable legislation and expectations from the user community.	Essential ☆☆☆
SAF-Q-4	Codify the service's availability and other non-functional aspects in a public Service Level Agreement (SLA) which is easy to understand by users from different communities.	Important ☆☆
SAF-Q-5	Implement processes following IT service management standards to: <ul style="list-style-type: none"> A. Bolster a reliable and predictable service delivery (including but not limited to capacity planning). B. Govern changes in a controlled way. Make release notes and documentation publicly available. Announce maintenance breaks well ahead of time. Maintain backward compatibility when possible. C. Deal with incidents or vulnerabilities in an effective and transparent way. 	Important ☆☆
SAF-Q-6	Implement and test disaster recovery procedures. In case of service interruptions, aim to restore the service as soon as possible, even if it requires workarounds or other temporary measures.	Important ☆☆
SAF-Q-7	Implement (ideally automated) testing procedures for every change to the service or a service (component) that it integrates with. Testing should ideally include not only functional testing, but also performance and stress testing.	Important ☆☆
SAF-Q-8	Implement and make available a set of metrics as indicators for the performance, stability and adoption of the service.	Important ☆☆

SAF-Q-9	Consider service scalability, if applicable.	Useful ☆
SAF-Q-10	Implement a service monitoring system that generates alerts in case of unexpected behavior, including functional, performance and security-related issues.	Useful ☆
SAF-Q-11	In addition to single services, also consider service networks and interdependencies.	Useful ☆

<i>Aspect: SAF-O Open & Connected</i>		
Objective: The service is operated in a low-barrier and inclusive way, seeking integrations and connections with other services and championing principles of openness consistent with Open Science and Open Research.		
Identifier	Recommendation	Priority
SAF-O-1	Publish clear, inclusive and non-discriminatory licences and/or terms of use. Enable wide access to the service.	Essential ☆☆☆
SAF-O-2	Seek integrations with other services rather than replicating functionalities, especially for common reusable infrastructure components. Provide documentation to ensure better sustainability for the network of integrations. Adopt the EOSC architectural components and standards as enablers for deep interoperability with other services in the EOSC portfolio ⁶ .	Essential ☆☆☆
SAF-O-3	Make the service and all documentation available online through URLs that are fully qualified domain names and assign PIDs where applicable.	Essential ☆☆☆
SAF-O-4	Use community-supported PIDs to integrate with other services. Keep data, metadata and PIDs tightly connected. Consider implementing	Essential ☆☆☆

⁶ Part of the EOSC interoperability framework, the EOSC Profiles (<https://data.d4science.net/13af>) specify common data models for EOSC entities (Providers, Resources, etc.), which helps drive the interoperability of resources within EOSC.

	existing models of object representation to enable interoperability with other data services ⁷ .	
SAF-O-5	Provide guidance about the service licensing to better understand the limitations in usage.	Important ☆☆
SAF-O-6	Adopt well-documented and community-supported open standards and specifications, in particular for APIs and other interfaces to better understand the service's usage.	Important ☆☆
SAF-O-7	Offer the service with the lowest possible entry barrier for end users (which does not preclude monetization or cost-recovery models).	Important ☆☆
SAF-O-8	Where possible, make any source code and related documentation that is used to run the service available under a common open-source licence. ⁸	Important ☆☆
SAF-O-9	Seek inclusion in relevant service catalogs, ideally obtaining and using a PID for the service.	Important ☆☆

Socially-oriented aspects

<i>Aspect: SAF-U User centrality</i>		
Objective: The service is managed so that it serves the (possibly evolving) goals of the user community and maximises usability while minimizing burden.		
Identifier	Recommendation	Priority
SAF-U-1	Ensure the service provider organization has adequate support staff available to assist users where needed.	Essential ☆☆☆
SAF-U-2	Invest in user training and outreach activities to help users understand the service's value proposition and how to effectively use it.	Essential ☆☆☆

⁷ A model with explicitly this target that is currently (2021) under development is the FAIR digital object framework <https://fairdigitalobjectframework.org/>.

⁸ See e.g. <https://spdx.org/licenses/> for a list of relevant software licences.

SAF-U-3	Ensure that sufficient documentation is available for users and organize a process to regularly review and update them (at least with every change to the service). The documentation should cover functional aspects and a description of the various service components and their relationship, and explain which phases of the data life cycle and data management processes are supported by the service. Ideally, the documentation should be version-controlled, and have a PID and an (open) licence.	Essential ☆☆☆
SAF-U-4	Strive for continual improvements to the user experience. In addition to making use of data and service usage statistics, actively work with the community to understand and improve usability, for example through user tests or design studios.	Essential ☆☆☆
SAF-U-5	Determine and monitor your target user community to understand how the service fits within its data management norms and expectations.	Important ☆☆
SAF-U-6	Ensure that there is an ongoing, consistent dialogue between the service and its user community, such that users can optimally make use of the service and influence its development.	Important ☆☆
SAF-U-7	Include multi-lingual support and accessibility features ⁹ , both for the service and its documentation, to the extent relevant for the service's (potential) user base. Key information must be available in English if the service is intended to be included within EOSC.	Useful ☆
SAF-U-8	Propose evaluation and assessment procedures where end users can provide feedback that can potentially influence the service's backlog and roadmap.	Useful ☆

Aspect: SAF-T Transparency

Objective: The service provider communicates with its stakeholders in a transparent manner.

Identifier	Recommendation	Priority
------------	----------------	----------

⁹ For accessibility on the web, we specifically recommend the Web Content Accessibility Guidelines (WCAG) overview: <https://www.w3.org/WAI/standards-guidelines/wcag/>

SAF-T-1	Clearly communicate the service's core value proposition and any pertinent (technical or non-technical) features, as well as its limitations.	Essential ☆☆☆
SAF-T-2	Be open and transparent about the organisational mission, business model, legal status and target user communities. Be accountable about the costs, profits and cost-recovery models to ensure trustworthiness in the service.	Essential ☆☆☆
SAF-T-3	Implement an appropriate and transparent governance structure that includes representation of the service's target user community.	Important ☆☆
SAF-T-4	Be clear about how the service implements community standards.	Important ☆☆
SAF-T-5	For services that are meant to preserve research objects over a longer period of time (such as data repositories), state a clear minimum preservation timeframe and provide a contingency and/or preservation plan.	Useful ☆
SAF-T-6	Seek to attain certification where relevant community-endorsed certification mechanisms exist.	Useful ☆

Aspect: SAF-L Longevity

Objective: The service provider designs the service with a timeframe for the maintenance and sustainability of the service in mind and implements measures accordingly, considering the researchers' need for reproducible research.

Identifier	Recommendation	Priority
SAF-L-1	Take reasonable measures to ensure sustainable long-term operation — including both financial and organisational aspects. Aim to reduce long-term operational dependencies on short-lived project funding. If available, provide clear information to indicate how long the service will minimally be available and maintained.	Essential ☆☆☆
SAF-L-2	Implement technical measures to safeguard the continuity of the service, and the longevity and integrity of any (meta)data that is stored as part of the service. This includes keeping backups in	Essential ☆☆☆

	independent systems, implementing fail-over mechanisms and exercising proper life cycle service management.	
SAF-L-3	Ensure that the service provider organization has sufficient staff with knowledge to operate the service <ul style="list-style-type: none"> A. to maintain the source code running the service, B. to make the service available to users, C. to keep the service relevant with business administration now and in the future. 	Important ☆☆
SAF-L-4	Plan the succession or decommissioning of the service to ensure a smooth transition when the service comes to the end of its life.	Important ☆☆

Aspect: SAF-E Ethical & Legal

Objective: The service complies with all applicable legal and ethical guidelines, in a transparent and auditable way.

Identifier	Recommendation	Priority
SAF-E-1	Take reasonable measures to manage the intellectual property rights of data producers.	Essential ☆☆☆
SAF-E-2	Define, publish and adhere to a code of conduct that is in accordance with commonly agreed principles regarding the conduct of research in the service's user community.	Essential ☆☆☆
SAF-E-3	Take reasonable measures to ensure data is handled in compliance with disciplinary and ethical norms, and that data licences are clearly defined and respected within global and local legislation ¹⁰ .	Essential ☆☆☆
SAF-E-4	Provide clear and user-friendly information about the extent of the data usage/access, in addition to the data licences.	Important ☆☆
SAF-E-5	Implement auditable measures to ensure that the service respects all applicable legislation and regulations concerning user privacy and	Important ☆☆

¹⁰ Note that although the focus of this recommendation is on ethical *handling*, there are situations where one cannot simply deny responsibility for the ethics of the *content*.

	sensitive data (including but not limited to GDPR in Europe). In particular, when processing personal data, roles and responsibilities must always be well-defined and data subjects must be provided with the name and contact details of the data controller and the Data Protection Officer.	
SAF-E-6	Clearly communicate a contact address for security issues including hacks, vulnerabilities and privacy breaches. Ensure the address is actively monitored by multiple staff members.	Useful ★

4. Conclusion

With this deliverable, we finalized the FAIRsFAIR service assessment framework, which includes seven aspects and fifty recommendations at different priority levels. This framework specifically targets service owners (i.e. individuals or organisations developing and operating services for research data). Nevertheless, it can be used by a multitude of stakeholders in the FAIR ecosystem. The framework is applicable across domains and applies to all types of services. The framework does not assign a FAIRness score to a service, its purpose is to support services in becoming more FAIR-enabling by highlighting areas for improvement.

The framework was first introduced in the FAIRsFAIR M2.10 report (Koers et al., 2020), which was based on methodological literature analysis, interviews with service owners and feedback gathered at the “FAIR certification of repositories and other data services” during EOSC-hub week 2019. After the first iteration, the task group conducted two separate workshops in February and in May 2021 to review the assessment framework and validate it. This deliverable marks the end of the process of refinement of the “framework for assessing FAIR enabling services”, during which the task group engaged with service owners - from identifier providers to repositories, ontology services and research and education network providers - and the wider FAIR community to improve and sharpen the framework.

Following this deliverable’s release, the task group will continue its work to disseminate the framework in different communities:

- We will liaise with other task groups in FAIRsFAIR to ensure the work presented here is aligned with their outputs. One example is to follow up on the work carried out in T4.1 on bringing CoreTrustSeal¹¹ and FAIR principles together.
- Furthermore, in the research software community, there is an ongoing debate about software as a service and including services in scope of the recently published FAIR for Research Software principles (Chue Hong et al., 2021). With the FAIRsFAIR service assessment framework, it is clear that services should be addressed differently than research

¹¹ <https://www.coretrustseal.org/>

objects. We will participate in the activity of the FAIR for Research Software (FAIR4RS) WG¹² to disseminate the FAIRsFAIR service assessment framework and complement the debate.

- The deliverable will be presented to the European Open Science Cloud (EOSC) where the framework can be applicable and useful for a wide range of stakeholders. We expect that future refinement of the framework will take place under the responsibility and/or guidance of the EOSC association and any relevant task forces¹³.

Beyond the lifespan of FAIRsFAIR (March 2022), possible activities for stakeholders continuing the work on FAIR service assessment are service owner training, collecting case studies of the framework's adoption and mapping of the different aspects from the FAIRsFAIR service assessment framework to other documents that focus on services in a FAIR ecosystem.

¹² <https://www.rd-alliance.org/groups/fair-research-software-fair4rs-wg>

¹³ <https://www.eosc.eu/news/draft-charters-eosc-association-task-forces-published>

5. References

- Chue Hong, N., Katz, D., Barker, M., Lamprecht, A.-L., Psomopoulos, F., Harrow, J., Castro, L., Gruenpeter, M., Martinez, P., Honeyman, T., 2021. FAIR Principles for Research Software (FAIR4RS Principles). <https://doi.org/10.15497/RDA00065>
- Digital Object Architecture | DONA Foundation [WWW Document], n.d. URL <https://www.dona.net/digitalobjectarchitecture> (accessed 7.14.21).
- Koers, H., Herterich, P., Gruenpeter, M., Hooft, R., Aalto, T., Koivula, H., 2021a. FAIRness of Services Workshop: A Closer Look at the FAIRsFAIR Framework. <https://doi.org/10.5281/zenodo.4680926>
- Koers, H., Herterich, P., Hooft, R., Gruenpeter, M., Aalto, T., 2020. M2.10 Report on basic framework on FAIRness of services. <https://doi.org/10.5281/zenodo.4292599>
- Koers, H., Herterich, P., Hooft, R., Gruenpeter, M., Aalto, T., Ramezani, S., 2021b. Basic framework on FAIRness of services - iteration 3. Zenodo. <https://doi.org/10.5281/zenodo.4771937>
- Ramezani, S., Herterich, P., Gruenpeter, M., Hooft, R., Aalto, T., 2021. FAIR-enabling Services: Validating The Framework. <https://doi.org/10.5281/zenodo.4791585>
- Wilkinson, M.D., Dumontier, M., Aalbersberg, I.J., Appleton, G., Axton, M., Baak, A., Blomberg, N., Boiten, J.-W., da Silva Santos, L.B., Bourne, P.E., Bouwman, J., Brookes, A.J., Clark, T., Crosas, M., Dillo, I., Dumon, O., Edmunds, S., Evelo, C.T., Finkers, R., Gonzalez-Beltran, A., Gray, A.J.G., Groth, P., Goble, C., Grethe, J.S., Heringa, J., 't Hoen, P.A.C., Hooft, R., Kuhn, T., Kok, R., Kok, J., Lusher, S.J., Martone, M.E., Mons, A., Packer, A.L., Persson, B., Rocca-Serra, P., Roos, M., van Schaik, R., Sansone, S.-A., Schultes, E., Sengstag, T., Slater, T., Strawn, G., Swertz, M.A., Thompson, M., van der Lei, J., van Mulligen, E., Velterop, J., Waagmeester, A., Wittenburg, P., Wolstencroft, K., Zhao, J., Mons, B., 2016. The FAIR Guiding Principles for scientific data management and stewardship. *Sci. Data* 3, 160018. <https://doi.org/10.1038/sdata.2016.18>

6. Bibliography

Note: The original inspiration for all of the recommendations in the framework were taken from different reports and papers. Since there is no 1:1 mapping from each recommendation back to the original literature, the below items are not explicitly referred to in the above text but were still very influential to this report.

- Andreas Ortmann Jaunsen, Mari Kleemola, Tuomas J. Alaterä, Heikki Lehvaslaiho, Adil Hasan, Josefine Nordling, and Pauli Assinen. 2020. 'D4.1 An Assessment of FAIR-Uptake among Regional Digital Repositories', August. <https://doi.org/10.5281/zenodo.4045402>.
- Corcho, Oscar, Magnus Eriksson, Krzysztof Kurowski, Milan Ojsteršek, Christine Choirat, Mark van de Sanden, and Frederik Coppens. 2020. 'EOSC Interoperability Framework : DRAFT'. <https://www.eoscsecretariat.eu/sites/default/files/eosc-interoperability-framework-v1.0.pdf>

- CoreTrustSeal. 2020. 'CoreTrustSeal Certified Repositories.' CoreTrustSeal. 2020. <https://www.coretrustseal.org/why-certification/certified-repositories/>.
- Deniz Beyan, Oya, Neil Chue Hong, Stefano Cozzini, Marta Hoffman-Sommer, Rob Hooft, Liisi Lemminen, Juuso Marttila, and Marta Teperek. 2020. 'Seven Recommendations for Implementation of FAIR Practice'. Zenodo. <https://doi.org/10.5281/zenodo.3931993>.
- Devaraju, Anusuriya, Robert Huber, Mustapha Mokrane, Linas Cepinskas, Joy Davidson, Patricia Herterich, Herve L'Hours, Jerry de Vries, and Angus White. 2020. 'FAIRsFAIR Data Object Assessment Metrics'. Zenodo. <https://doi.org/10.5281/zenodo.3934401>.
- European Commission Expert Group on FAIR Data. 2018. 'Turning FAIR into Reality: Final Report and Action Plan from the European Commission Expert Group on FAIR Data.' Brussels: European Commission. Directorate-General for Research and Innovation. <https://doi.org/10.2777/1524>.
- Genova, Francoise, Jan Magnus Aronsen, Oya Beyan, Natalie Harrower, Andr s Holl, Leslie McIntosh, Pedro Principe, Kostas Repanas, Ana Slavec, and Sarah Jones. 2020. 'Interim Recommendations on Certifying the Services Required to Enable FAIR Research Outputs within EOSC'. <https://repository.eoscsecretariat.eu/index.php/s/zCnHTcytBHaLjRp#pdfviewer>.
- Herv  L'Hours, Ilona von Stein, Frans Huigen, Anusuriya Devaraju, Mustapha Mokrane, Joy Davidson, Jerry de Vries, Patricia Herterich, Linas Cepinskas, and Robert Huber. 2020. 'D4.2 Repository Certification Mechanism: A Recommendation on the Extended Requirements and Procedures', May. <https://doi.org/10.5281/zenodo.3835698>.
- Koers, Hylke, Daniel Bangert, Emilie Hermans, Ren  van Horik, Maaik de Jong, and Mustapha Mokrane. 2020. 'Recommendations for Services in a FAIR Data Ecosystem'. Patterns 0 (0). <https://doi.org/10.1016/j.patter.2020.100058>.
- Koers, Hylke, Morane Gruenpeter, Patricia Herterich, Rob Hooft, Sarah Jones, Jessica Parland-von Essen, and Christine Staiger. 2020. 'Assessment Report on "FAIRness of Services"', February. <https://doi.org/10.5281/zenodo.3688762>.
- Lin, Dawei, Jonathan Crabtree, Ingrid Dillo, Robert R. Downs, Rorie Edmunds, David Giarretta, Marisa De Giusti, et al. 2020. 'The TRUST Principles for Digital Repositories'. Scientific Data 7 (1): 144. <https://doi.org/10.1038/s41597-020-0486-7>.
- Orviz, Pablo, Mario David, Jorge Gomes, Joao Pina, Samuel Bernardo, Isabel Campos, Germ n Molt , Miguel Caballer, and EOSC-SYNERGY. 2020. 'EOSC-Synergy: A Set of Common Service Quality Assurance Baseline Criteria for Research Projects', June. <https://doi.org/10.13039/501100000780>.
- Papale, Dario. 2020. 'ENVRI-FAIR D11.1 Biodiversity and Ecosystem Subdomain Implementation Short Term Plan', February. <https://doi.org/10.5281/zenodo.3885361>.
- Research Data Alliance FAIR Data Maturity Model Working Group. 2020. 'FAIR Data Maturity Model: Specification and Guidelines'. <https://doi.org/10.15497/RDA00050>.
- Riungu-Kalliosaari, Leah, Rob Hooft, Sylvia Kuijpers, Jessica Parland-von Essen, and Jonas Tana. 2020. 'D2.4 2nd Report on FAIR Requirements for Persistence and Interoperability', August. <https://doi.org/10.5281/zenodo.4001631>.
- Wilkinson, Mark D., Michel Dumontier, Susanna-Assunta Sansone, Luiz Olavo Bonino da Silva Santos, Mario Prieto, Dominique Batista, Peter McQuilton, et al. 2019. 'Evaluating FAIR Maturity through a Scalable, Automated, Community-Governed Framework'. Scientific Data 6 (1): 174.

<https://doi.org/10.1038/s41597-019-0184-5>.

Wittenburg, Peter. 2019. 'From Persistent Identifiers to Digital Objects to Make Data Science More Efficient'. Data Intelligence 1 (1): 6–21. https://doi.org/10.1162/dint_a_00004.