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Abstract

This deliverable report offers details on the development of the GraspOS federated infrastructure, and contains references to the code repositories and the documentation websites of the respective software packages. This is the second version of the respective deliverable providing refinements and updates to everything reported in D4.3, that has been submitted in December 2023.

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Author List

Organisation	Name	Contact Information
ARC	Thanasis Vergoulis	vergoulis@athenarc.gr
CNR	Andrea Mannocci	andrea.mannocci@isti.cnr.it
OpenAIRE	Giulia Malaguarnera	giulia.malaguarnera@openaire.eu

Reviewer List

Organisation	Name	Contact Information
TSV	Janne Polonen	janne.polonen@tsv.fi
EGI	Alessandro Paolini	alessandro.paolini@egi.eu
TUBITAK	Selcuk Bilmis	selcuk.bilmis@tubitak.gov.tr

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Abbreviation List

- **API:** Application Programming Interface
- **CKAN:** Comprehensive Knowledge Archive Network
- **DB:** Database
- **DIAL:** Data Interoperability & Access Layer

- **EOSC:** European Open Science Cloud
- **FOMI:** Open & Federated Research Assessment Infrastructure (previously called "Federated Open Metrics Infrastructure")
- **ID:** Identifier
- **OS:** Open Science
- **OS-aware RRA:** Open-Science-aware Responsible Research Assessment
- **OSAF:** Open Science Assessment Framework
- **PID:** Persistent Identifier
- **QoS:** Quality of Service
- **RDA:** Research Data Alliance
- **RFO:** Research Funding Organization
- **RPO:** Research Performing Organization
- **RRA:** Responsible Research Assessment
- **SKG:** Scientific Knowledge Graphs
- **SKG-IF:** Scientific Knowledge Graphs Interoperability Framework
- **UI:** User Interface
- **URL:** Uniform Resource Locator

1. Executive Summary

Research assessment plays an important role in various aspects of research, from guiding the hiring and promotion of researchers to shaping strategic investments and policymaking. GraspOS aims to deliver a federated infrastructure, referred to as 'FOMI' in the original project plan, which will support research assessment processes by integrating and providing easy access to a range of valuable resources, including data, tools, services, templates, and guidance materials. This infrastructure will focus on enabling Open Science-aware Responsible Research Assessment (OS-aware RRA), effectively catalysing the creation of an open, federated research assessment dataspace.

The infrastructure is designed to be modular and scalable, allowing for the integration of new resources as needed. It is also designed to be open and accessible, enabling the research community to contribute to its development and use. The infrastructure is based on a federated architecture and is distributed across multiple locations to be more resilient and adaptable to changing needs and contexts. It consists of core catalogues and registries that facilitate the discovery of research assessment resources, a Data Interoperability & Access Layer (DIAL) that enhances the interoperability of federated data sources, and a web-based

front-end that serves as the entry point to the infrastructure. This front-end informs end-users about the contents and helps them identify federated resources of interest. Additionally, the catalogues are designed to integrate seamlessly with the EOSC ecosystem.

This report details the implementation of the core components of the GraspOS infrastructure and provides references to the relevant code repositories and documentation materials. Section 2 offers the necessary background, explaining key terminology and presenting a high-level overview of the GraspOS infrastructure architecture (with further details available in D4.2). Section 3 elaborates on the implementation of the core components, while Section 4 provides references to the respective code bases and documentation materials. Finally, Section 5 concludes the report.

2. Background

Nowadays, commonly used practices for research assessment face major challenges (e.g., related to the use and abuse of often misunderstood and non-transparent quantitative indicators, the reliance on proprietary data sources, or putting too much emphasis on publications while ignoring other types of contributions in research). As a result, there is a growing recognition that assessing research and researchers needs to be done in a more responsible way[1], which will take into consideration (a) the values, scope, and context of each assessment event, (b) qualitative evidence together with supporting quantitative data and indicators, and (c) multiple aspects and merits of research work that should be acknowledged. At the same time, research assessment processes should enable transparency in the assessment processes, focusing on the use of open scholarly data sources. Finally, since openness in science is widely recognized as important due to its effect in research credibility and knowledge sharing, there is a need for frameworks and technologies that will enable an *Open-Science-aware Responsible Research Assessment (OS-aware RRA)* to encourage and reward the adoption of OS practices from researchers.

GraspOS aims to address these issues by designing and delivering an open and federated research assessment infrastructure. This infrastructure was mentioned in the project plan as the "Federated Open Metrics Infrastructure (FOMI)" however, for brevity, we will refer to it as the GraspOS infrastructure from now on. The GraspOS infrastructure is designed to aggregate open resources (data, tools, services, templates, and guidance materials) that can catalyse the implementation of policy reforms towards OS-aware RRA. Figure 1, presents a high-level conceptual architecture of the infrastructure.

[1] CoARA, 2022, The Agreement on Reforming Research Assessment. https://coara.eu/agreement/the-agreement-full-text/

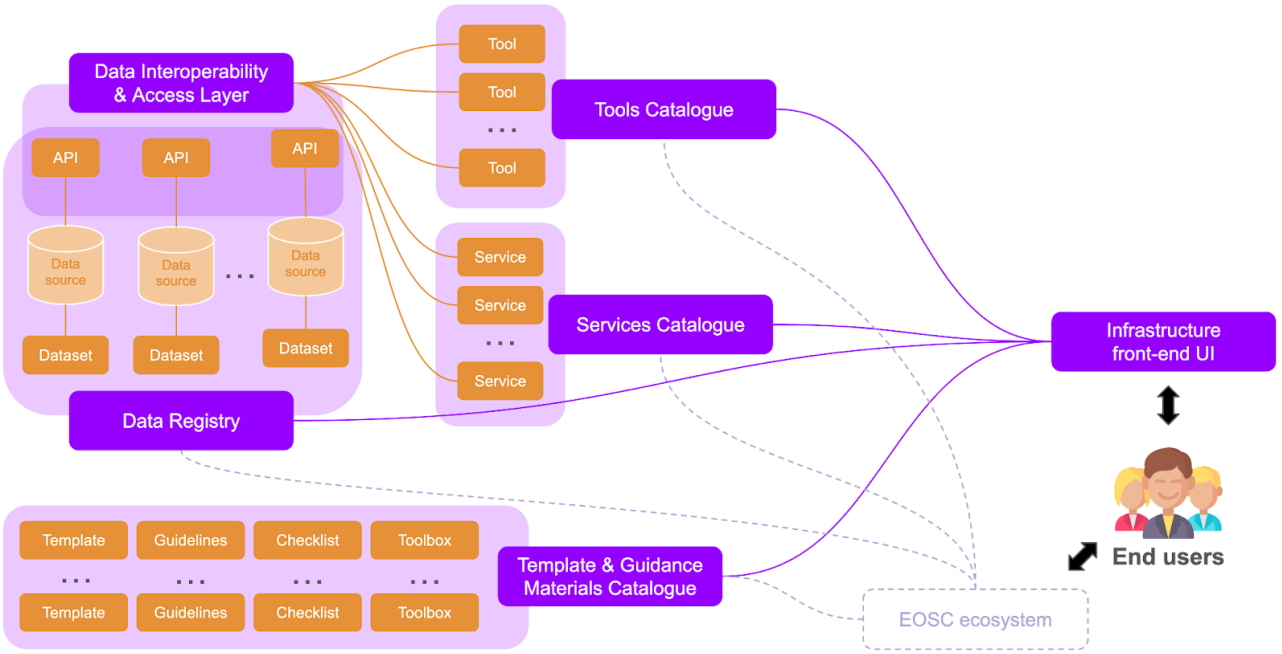

Figure 1 *Overview of the GraspOS infrastructure core components*

The architecture mainly consists of a series of core catalogues and registries that facilitate the discovery of research assessment resources, a Data Interoperability & Access Layer (DIAL) that improves interoperability of the federated data sources, and a Web-based front-end that acts like the entry point to the infrastructure informing the end-users about the contents and assisting them in identifying federated resources of interest. Additionally, the catalogues are designed in a way to facilitate the discoverability of the respective resources in the EOSC ecosystem.

Detailed description of the initial architecture design is described in D4.1 - "Infrastructure Architecture (v1)"[2] and D4.2 "Infrastructure Architecture (v2)" (to be published soon). The current report contains references to the code bases of the software packages that contribute to the creation of the GraspOS infrastructure and documents their implementation. An initial version of this deliverable has already been published on August 2023[3]. In this version, apart from updating the code base or documentation links accordingly, we have also restructured the document in an attempt to reduce overlaps with the architectural design deliverables. The focus of the following sections is to offer implementation details on the core software components of the GraspOS infrastructure.

[2] D4.1 "Infrastructure architecture": https://zenodo.org/records/8302198
[3] D4.3 "Federated Open Metrics Infrastructure": https://zenodo.org/doi/10.5281/zenodo.10475567

3. Implementation

This section offers implementation details for the various core components of the GraspOS infrastructure. The respective descriptions correspond to the current, beta versions of the components, which are expected to be extended, improved, and refined until the end of the project.

3.1. Data Registry

This component enables users to discover, understand, and search for data assets within the GraspOS infrastructure. The datasets registered in the GraspOS Data Registry include raw or structured data that can be used to either directly support the conduction of OS-aware RRA events or produce indicators, track records, narratives or other evidence that could be valuable in such processes. The Data Registry aggregates metadata and access information for all datasets and data sources federated within the GraspOS system. More specifically, apart from a set of basic metadata related to each dataset (e.g., its title, owners, licence), the GraspOS Data Registry also contains information about the location of the respective GraspOS API deployment, enabling the programmatic access to the data source contents.

The GraspOS Data Registry is developed based on The Comprehensive Knowledge Archive Network (CKAN).[4] CKAN is an open-source (according to AGPL licence) software, maintained by the Open Knowledge Foundation,[5] that enables the storage and distribution of open data. CKAN was initially inspired by the package management system of Debian Linux, but has evolved into a robust data cataloguing tool. At the time of writing, it is widely used by numerous organisations worldwide to share their data with the general public.

For the user interface of the GraspOS Data Registry, we have created a customised version of the Web interface offered by CKAN. More specifically, the respective software has been deployed on a Web server hosted in ATHENA RC's data centre in Athens, Greece[6]. From the end-user perspective, CKAN's Web UI offers keyword search and filtering functionalities that can facilitate the discoverability of data assets (see also Figure 2). It is also capable of providing visualisation functionalities exposing data as line, bar, and pie charts.

[4] CKAN: https://ckan.org/
[5] Open Knowledge Foundation: https://okfn.org/en/
[6] GraspOS Data Registry: https://graspos-data.athenarc.gr/

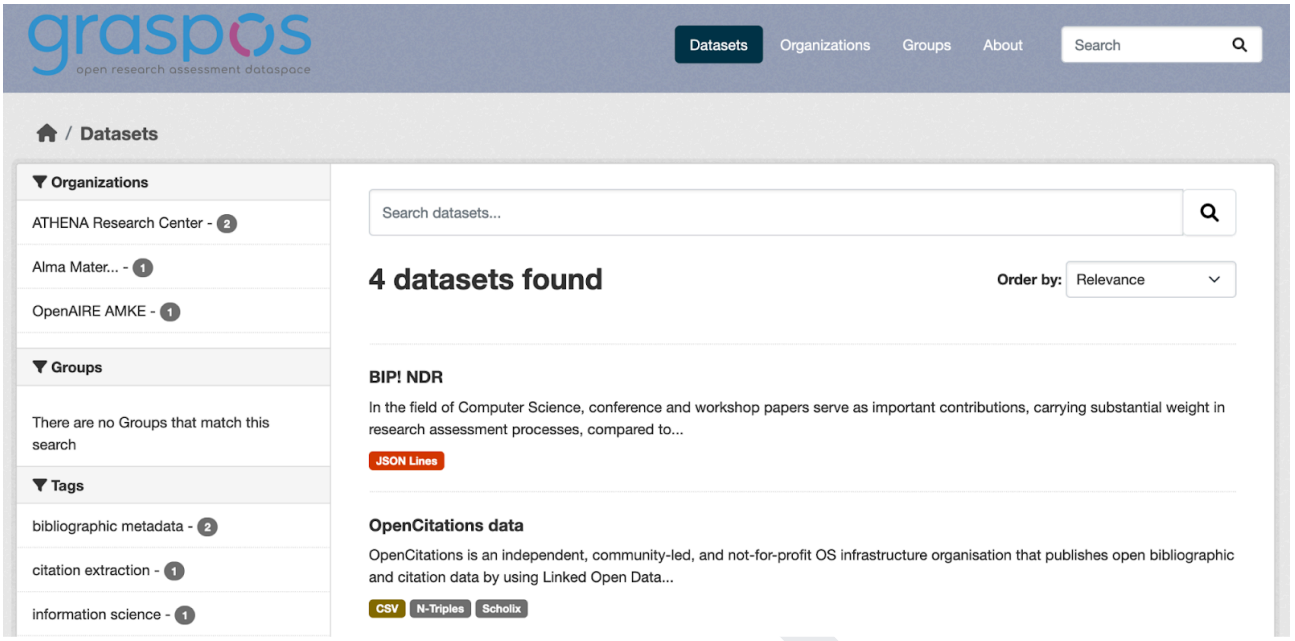

Figure 2 *The main page of the GraspOS Data Registry UI.*

From the administrator perspective, the UI allows for the easy registration, update, and refinement of datasets and data sources. Each dataset consists of one or more resources representing different data files. The UI is highly customisable enabling not only theming (using custom-made styling templates), but also adapting the selection of functionalities to be offered as well as developing software extensions. GraspOS experts have established a deployment of CKAN integrating custom-made extensions tailored to the needs of the GraspOS project.

Due to its implementation, the GraspOS Data Registry can also be used by external code using the CKNA API. This functionality can be very useful for the improved integration of the registry with other core components of the GraspOS architecture. For instance, this feature can facilitate the implementation of advanced search functionalities through the Infrastructure Front-end UI (see Section 3.6).

Under the hood, the GraspOS Data Registry is storing not only the traditional set of metadata which are provided by default by CKAN but also additional attributes suggested by the internal “Working Group on Resource Metadata Schemas” (see also Section 3.1 “Methodology” of D4.2 “Infrastructure architecture”). The current set of metadata kept for each dataset and resource are currently those presented in Table 1.

Table 1 *Metadata model for GraspOS datasets & resources*

Dataset metadata fields	
Field	**Explanation**
Title	The title of the dataset.
Description	The short description of the dataset.
Tags	Keywords describing the dataset.
Licence	The licence based on which the dataset is becoming available.
Organisation	The organisation to which the dataset belongs.
Visibility	The visibility (public/private) of the dataset in the registry.
Source	The original source or origin of the dataset.
Version	The version of the dataset.
Authors	The list of people or organisations responsible for producing the dataset.
API URL	The URL of the API deployment of the dataset.
API URL instructions	Instructions for accessing the dataset API.
Documentation URL	The URL containing the documentation material related to the dataset.
Contact person	The name of the person to which queries about the data should be sent.
Contact person email	The email of the person to which queries about the data should be sent.
Resource metadata fields	
Field	**Explanation**
Name	The name for this resource.
Description	The short description of the resource.
Format	The file format of the resource, e.g. CSV (comma-separated values), XLS, JSON, PDF, etc.

URL	Link to data files (or reference to uploaded files).
Created	The date and time when the resource was initially added to the registry.
Data last updated	The date and time when the actual data content of the resource was last updated.
Metadata last updated	The date and time when the resource's metadata was last updated.

It should be noted that it is possible for these metadata to be further extended in the future based on updated recommendations made by the aforementioned working group. By extending CKAN's metadata model, we empower users to be informed for specific details that are crucial for research assessment (e.g., the type of research assessment evidence or indicators that can be found inside the respective dataset).

3.2. Tools Catalogue

This component aims to facilitate the discovery of GraspOS tools by collecting their metadata offering also an integration with EOSC. The tools registered in the GraspOS Tools catalogue are stand-alone pieces of software, such as scripts, executables, libraries, or even workflows, which can be used by installing and executing them locally on a computer or computational cluster owned by the end-user to conduct a particular type of analysis and/or produce data in the context of research assessment events or related processes. The implementation of the Tools catalogue is based on a Zenodo[7] community, called "GraspOS Tools"[8]. Zenodo is a free and open digital archive, developed by CERN and OpenAIRE, that enables researchers to share and preserve any kind of research output, such as papers, data, software, reports, and more, supporting the principles of Open Science and open access. Zenodo communities are shared areas in Zenodo where users can collaborate, curate, and manage research outputs. The representatives of each community can review and accept submissions from other Zenodo users. They can also customise the community metadata and information (e.g., the logo, the description).

Naturally, the GraspOS Tools Catalogue UI is based on the Web interface of the aforementioned Zenodo community, which has been customised to include the GraspOS logo and relevant textual descriptions. The basic searching, filtering, and ordering functionalities

[7] Zenodo: https://zenodo.org/
[8] GraspOS Tools Catalogue: https://zenodo.org/communities/graspos-tools

offered by the Zenodo platform are available to the GraspOS Tools Catalogue end users. Figure 3, presents a snapshot of the GraspOS Tools Catalogue UI.

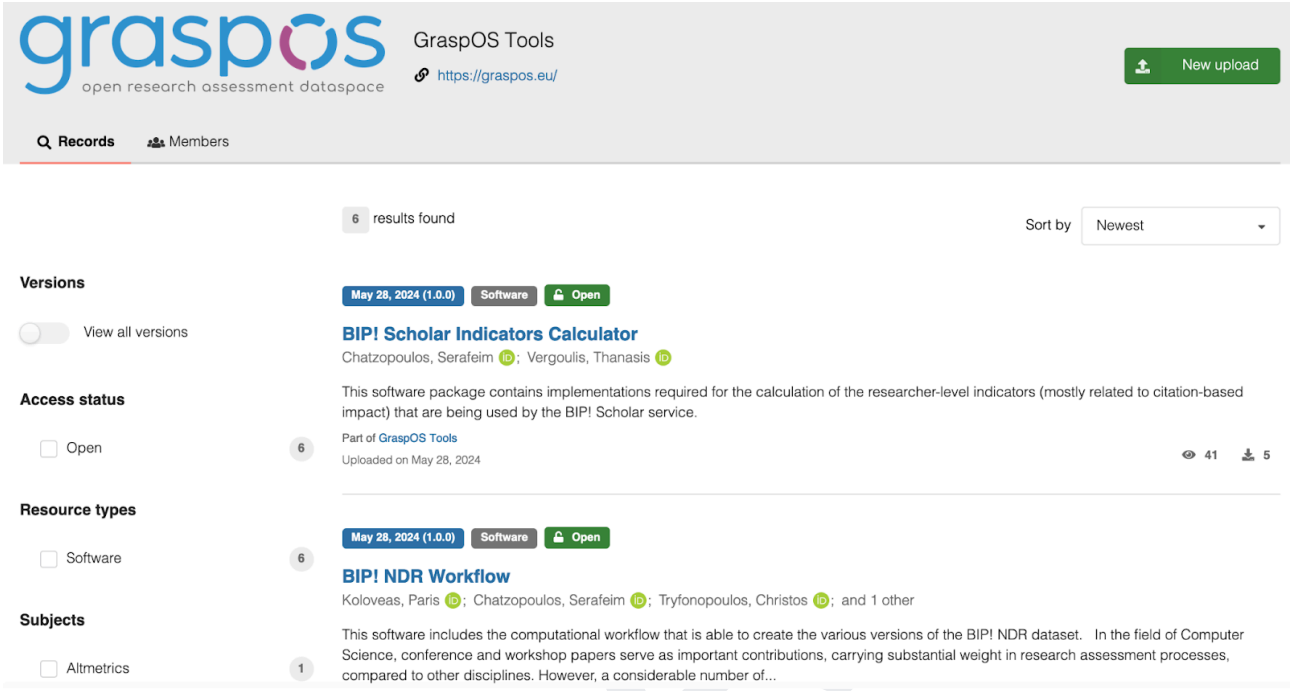

***Figure 3** The main page of the GraspOS Tools Catalogue UI.*

Based on this implementation, each GraspOS tool is expected to be registered to this community creating a "Software" entry. Each tool provider is required to provide values for all mandatory fields for Zenodo software entries. Additionally, a controlled vocabulary of keywords has been created by the internal "Working Group on Resource Metadata Schemas" and is required for the providers to tag with those that are relevant to their tool so that additional information is provided to the end users. Table 2 outlines the current version of the controlled vocabulary and includes the related categories from the GraspOS Tools Classification Taxonomy[9] (star is used to denote all relevant categories).

***Table 2** Controlled vocabulary for keywords to tag GraspOS Tools*

Keyword	Mapped category in Tools Classification
Scholarly Data Enrichment	Scholarly Data Enrichment (SDE) Tools > *
Research Assessment	*
Indicators	Scholarly Data Enrichment (SDE) Tools > Indicators

[9] More information in D3.2 "Tools & Services": https://zenodo.org/doi/10.5281/zenodo.13619176

Research Monitoring	OS Monitoring (OSM) Tools > *
Open Science Monitoring	OS Monitoring (OSM) Tools > *

For tool versioning, the current approach mandates publishing a new version of the respective Zenodo software entry whenever significant changes are made to the respective tool. However, the internal GraspOS "Working Group on Resource Metadata Schemas" will explore ways to streamline this process, such as leveraging connections between Zenodo and GitHub[10], during its second phase of consultations starting in fall 2024.

Until now, every GraspOS tool that has been identified has also been registered to the GraspOS Tools Catalogue. Since Zenodo is being harvested by OpenAIRE for the creation of the OpenAIRE Graph[11], which is the basis for the research software entries in the the Resource Hub of the EOSC EU Node[12], all GraspOS tools will be discoverable through EOSC's main discovery platform. Finally, the end user can leverage the advanced search and browsing capabilities already provided by Zenodo to its users to perform advanced searching. As it is evident, after identifying a tool of interest, the end user will need a computational system to run it and some basic technical skills to install/deploy it.

3.3. Services Catalogue

The aim of this component is to facilitate the discovery of GraspOS services by collecting and indexing their metadata. The services collected in the GraspOS Services Catalogue are pieces of software that provide a set of functions or features for the end user, which can be helpful in the context of research assessment processes and that are typically hosted on a remote server or cluster and accessed via a Web interface or API. Essentially, the service providers aim to offer them in a 24/7 manner giving guarantees for the respective Quality of Service (QoS), such as the service availability. The GraspOS Services Catalogue is also expected to facilitate the integration of the previous services into the EOSC ecosystem.

The Services Catalogue essentially provides GraspOS end-users with a centralised and intuitive platform to explore and access the various services offered. It is based on the OpenAIRE Catalogue open-source software.[13] The backend of the OpenAIRE Catalogue is

[10] https://zenodo.org/account/settings/github/
[11] The OpenAIRE Graph: https://graph.openaire.eu/
[12] EOSC EU Node Resource Hub: https://open-science-cloud.ec.europa.eu/resources/all
[13] The OpenAIRE Catalogue: https://github.com/madgeek-arc/resource-catalogue-ui-openaire & https://github.com/madgeek-arc/openaire-catalogue

implemented in Java using the Spring Boot framework[14], ensuring a scalable and efficient foundation that guarantees not only reliability but also swift responses to user queries and dynamic updates. Its frontend, on the other hand, is implemented in Angular[15] and delivers a responsive, and dynamic user interface. The Angular framework facilitates the creation of a seamless and interactive user interface, enabling intuitive navigation and exploration of the available service. Users can effortlessly search, filter, and discover pertinent information about each service, enhancing their overall engagement.

Regarding the metadata model to be used for the GraspOS services catalogue, the internal "Working Group on Resource Metadata Schemas" has selected to use the set of mandatory fields from the OpenAIRE catalogue data mode. Table 3 outlines these fields together with descriptions about their interpretations and data types. In the future, this metadata model will be further extended to include additional fields according to the recommendations from the internal working group.

Table 3 *GraspOS Services metadata model*

Field name	Description	Type
Name	Brief & descriptive name of the Resource given by the Provider.	string
Abbreviation	Abbreviation or short name of the Resource.	string
Resource Organisation	The organisation name that manages or delivers the resource, or coordinates the Resource delivery in a federated scenario.	related organisation
Webpage	Web Page with information about the Resource usually hosted and maintained by the Provider.	hyperlink
Tagline	Short catchphrase for marketing and advertising purposes. It will be usually displayed close to the Resource name and should refer to the main value or purpose of the Resource.	text
Short description	The pitch deck. Follows a specific wording: [Name of service] is a [what] that does [how] For [who] By	text
Long description	A high-level description in fairly non-technical terms of a) what the Resource does, functionality it provides and Resources it enables to access, b) the benefit to a user/customer delivered by a Resource; benefits are usually related to alleviating pains (e.g., eliminate undesired outcomes, obstacles or risks) or producing gains (e.g. increased performance, social gains, positive emotions or cost saving), c) list of customers, communities, users, etc. using the Resource.	string

[14] Spring Boot framework: https://spring.io/projects/spring-boot
[15] Angular: https://angular.dev/

Logo	Link to the logo/visual identity of the Resource. The logo will be visible at the Portal. If there is no specific logo for the Resource the logo of the Provider may be used. Go to the Resource Provider's website --> Right Click on the Resource Provider's logo on the website --> Select "Copy Image Link" --> Paste it in the below field.	hyperlink to logo image
Scientific domain	The branch of science, scientific discipline that is related to the Resource.	Controlled value
Scientific subdomain	The sub-branch of science, scientific subdiscipline that is related to the Resource.	Controlled value
Category	A named group of Resources that offer access to the same type of Resources.	Controlled value
Subcategory	A named group of Resources that offer access to the same type of Resources, within the defined Resource category.	Controlled value
Target users	Type of users that commissions a Provider to deliver a Resource.	Controlled value
Geographical Availability	Locations where the Resource is offered.	string - Please specify a list of countries or "Worldwide"
Language Availability	Languages of the (user interface of the) Resource.	string - Please specify a list of languages
Main contact - First Name	First Name of the Resource's main contact person/Resource manager.	string
Main contact - Last Name	Last Name of the Resource's main contact person/Resource manager.	string
Main contact - Email	Email of the Resource's main contact person/Resource manager.	email
Public contact - Email	Email of the Resource's contact person or a generic email of the Provider to be displayed publicly at the Portal.	email
Helpdesk - Email	The email to ask more information from the Provider about the Resource.	email
Security contact - Email	The email to contact the Provider for critical security issues about the Resource.	email

Technology Readiness Level (TRL)	The Technology Readiness Level of the Resource.	Controlled value
Terms of use	Webpage describing the rules, Resource conditions and usage policy which one must agree to abide by in order to use the Resource.	hyperlink
Privacy policy	Link to the privacy policy applicable to the Resource.	hyperlink
Order type	Information on the ordering process type.	Controlled value
Documentation	Service documentation page.	hyperlink
Banner Image	Vertical image that will be displayed as a banner on the main page	hyperlink
Card Image	Image that will be displayed on cards when the resource is shown as a related service.	hyperlink

During the development phase of the GraspOS Catalogue, a local deployment of the OpenAIRE Catalogue, hosted on an ATHENA's server in Athens (Greece), is used.

3.4. Templates & Guidance Material Catalogue

The aim of this component is to facilitate the discovery of resources facilitating the assessment process, which are developed as part of the Open Science Assessment Framework (OSAF):

- ***templates for documents,*** which can be used during the research assessment process, such as templates for documenting the assessment readiness, stakeholder mapping, value and/or purpose statement of the respective research assessment events, or similar resources (see also Section 4 of D2.2 "OSAF"[16]).
- ***guidance documents***, which can inform readers on subjects related to responsible and OS-aware research assessment, such as the Open Science Assessment Guide and the EDI guide introduced by GraspOS WP2 (see also Section 4 of D2.2).
- ***checklists***, which are systematic list of steps arranged in a specific order, used as a tool to ensure that all necessary actions for research assessment processes are taken and nothing is overlooked (see also Section 4 of D2.2)

[16] GraspOS Deliverable 2.2: https://zenodo.org/doi/10.5281/zenodo.10475459

- ***indicator toolboxes***, which are comprehensive collections of metrics and indicators designed to estimate various aspects of research performance, impact, and quality (see also Section 4 of D2.2)

The Templates & Guidance Material Catalogue is a recent addition to the list of GraspOS registries and catalogues, based on the work reported in D2.2. Its implementation has not started yet, however the intention is to follow a similar approach like the one used for the implementation of the Tools Catalogue. This means that the current plan is to create a dedicated Zenodo community that will collect the previous types of resources. A first version of this catalogue (including a first batch of related resources) is expected to be available sometime in Q4 of 2024.

3.5. Data Interoperability & Access Layer (DIAL)

The GraspOS infrastructure contains a "Data Interoperability and Access Layer" (called "DIAL" for brevity) which aims to facilitate the integration and harmonisation of (meta)data from various sources and formats within the infrastructure. This aims to ease the work of developers in implementing tools and added-value services on top of the respective data sources.

The Data Interoperability & Access Layer essentially comprises the union of all the API endpoints that offer access to the contents of the (federated) data sources included in the GraspOS infrastructure. During the lifetime of the project, the plan is for all data sources to offer API endpoints which are compatible (and interoperable) with each other. To this end, GraspOS is building upon the guidelines and specifications of widely accepted standards (e.g., those provided by RDA[17] like the "Scientific Knowledge Graph Interoperability Framework"[18] (SKG-IF) delivered by the respective RDA working group) and the EOSC Interoperability Framework.[19] To coordinate this activity, GraspOS has created an internal working group of experts (called the "Internal Working Group on Data Interoperability and Access"). The main output of this group is expected to be the GraspOS data model and API specification, an extension of SKG-IF tailored for research assessment applications (see also D4.2[20] for additional details on the design process).

[17] Research Data Alliance (RDA): https://www.rd-alliance.org/
[18] Scientific Knowledge Graph Interoperability Framework (SKG-IF): https://skg-if.readthedocs.io/
[19] EOSC Interoperability Framework (EOSC IF): https://op.europa.eu/s/zQFF
https://eosc-portal.eu/eosc-interoperability-framework/about-eosc-interoperability-framework-governance-eosc-if
[20] GraspOS Deliverable 4.2: https://zenodo.org/doi/10.5281/zenodo.13618531

Based on the discussions that took place in the GraspOS working group on Data Interoperability and Access, a first version of the planned SKG-IF extension has been prepared. The focus of the first version was given on the inclusion of indicators and narratives, since these were the most important missing notions that have been identified.

The inclusion of **indicators** is planned as an extension of the Research product, Person and Organisation entity types. In this case, a new optional JSON field, named "`indicators`", can be added to the records of the aforementioned entities. Since all the properties of a record are optional, with the exception of record IDs, data providers can, by design, exchange indicators about an entity without being forced to share any other property (e.g., bibliographic information for Research products).

The "`indicators`" field will be a list of predetermined indicator categories, each of which will list an ensemble of relevant indicators (supported by the data source for the respective entity type) and their values. Hence, the structure of the field will be the following:

```
"indicators": {
   "category_a": [
      "indicator_id_a1": "value",
      "indicator_id_a2": "value"
   ],
   "category_b": [
      "indicator_id_b1": "value",
      "indicator_id_b2": "value",
      "indicator_id_b3": "value"
   ],
   ...
}
```

Each indicator is expected to have a unique identifier (controlled by the data source) and a value, which could be either numeric or textual, to support both traditional indicators but also categorical ones, or even badges. Categories of indicators are specific for each entity type to which the indicators are relevant. For example, for a Research product, the indicator categories can relate to different aspects such as Impact, Usage, Novelty, and FAIRness. For Person, instead, indicator categories can take inspiration from the OPUS Research Assessment Framework (RAF)[21] and the indicator groups there defined. However, the controlled vocabulary for these categories has not yet been finalised, and the internal working group will complete this work in its second phase in autumn 2024.

The inclusion of **narratives** is planned as the addition of a brand-new entity and its specific relationships with the SKG-IF core entities. A narrative will contain an optional "`title`" and a mandatory "`content`" field (both will be free text fields). Similarly to all SKG-IF entities,

[21] https://opusproject.eu/wp-content/uploads/2023/09/OPUS_D3.1_IndicatorsMetrics_FINAL_PUBLIC.pdf

narratives will need IDs and `entity_type`, in this case, set to `"narrative"`. Moreover, an optional field named `"template"` (of type String) will provide information on the template used to create the narrative (e.g., in case a template of Narrative CVs is used) while two optional fields named `"creation"` and `"last_update"` will keep a timestamp for the creation and the last modification of the narrative. A field named `"authors"` will be a list containing the identifiers of the authors of the narrative. Since narratives can be potentially related to Research Products, Persons, and Organisations, this entails the inclusion of a field named `"related_entities"` in the Narrative entity type to materialise the respective relationships. The field will contain a property named `"entities_type"`, that determines the type of the connected entities (i.e., Research Product, Person, Organisation) and another one named `"entities"`, that is a list of identifiers representing the connected items to the narrative.

The GraspOS metadata model (i.e., the respective SKG-IF extension) is designed to facilitate metadata exchange between the onboarded metadata sources and value-added services. While it can be used as the schema of bulk download files, its main purpose is to act as a blueprint for the endpoints, the parameters, and the responses of the APIs that will be provided by each GraspOS data service. To this end, the metadata model is used to define a basic, API resolver specification capable of returning entries compatible to the GraspOS model for a given identifier. In the context of GraspOS, the providers of the federated sources will build upon these data models and specifications to create a set of guidelines for onboarding data asset sources to the GraspOS infrastructure (and the respective dataspace in the future) and will work on making the required changes from their side and deploying the required API endpoints so that their sources will be federated.

In the context of GraspOS, the data service providers are building upon the aforementioned specification to make the required changes from their side and deploy the required API endpoints so that their sources will be federated. Finally, being compliant to the specifications of the GraspOS Data Interoperability & Access Layer, will be one of the requirements for onboarding additional data sources to the GraspOS infrastructure in the future (see also Section 5.2 of D4.2).

3.6. Infrastructure Front-end UI

This component is a front-end user interface (UI) that can be used by the GraspOS end-users to help them navigate between the various catalogues and registries of the GraspOS infrastructure[22], but also to explore the resources (data, tools, and services) hosted and exposed by the GraspOS infrastructure. This UI is essentially the entry point to the infrastructure.

The development of this component is based on Docusaurus,[23] a framework that allows building and deploying customised and highly optimised project websites. It leverages Markdown to add the website's content, thus simplifying the authoring process and enabling content writers lacking technical background to focus on delivering high-quality, informative content without a steep learning curve.

Meanwhile, this front-end UI is highly adaptable and responsive, a direct result of Docusaurus's built-in support for mobile devices. It offers a consistent and user-friendly experience across a wide range of devices, ensuring that the content scales seamlessly to fit different screen sizes. It also allows dynamic code to be included, hence it supports implementing advanced features (for instance, to support advanced navigation functionalities). Last but not least, its built-in support for versioning and several deployment additions/plugins have streamlined our website's maintenance process, allowing us to effortlessly update content and deploy changes promptly.

[22] GraspOS Infrastructure front-end UI: https://graspos-infra.athenarc.gr/
[23] Docusaurus: https://github.com/facebook/docusaurus

4. Code Repositories & Implementation

This section contains references to the code base of the GraspOS infrastructure core components and the respective documentation.

4.1. GraspOS Registries & Catalogues

The following table lists the code repositories, the current deployments, and the documentation websites of all the core infrastructure components.

Table 4 *GraspOS Registries & Catalogues Overview*

Component	Code repository	Current deployment	Documentation
Infrastructure Front-end UI	https://github.com/athenarc/graspos-infra	https://graspos-infra.athenarc.gr/	https://github.com/athenarc/graspos-infra/blob/master/README.md
Data Registry	https://github.com/athenarc/graspos-registry	https://graspos-data.athenarc.gr/	https://github.com/athenarc/graspos-registry/blob/main/README.md
Services Catalogue	Front-end: https://github.com/athenarc/graspos-services-catalogue-frontend Back-end: https://github.com/athenarc/graspos-services-catalogue-backend	https://graspos-services.athenarc.gr/home	https://github.com/athenarc/graspos-services-catalogue-frontend/blob/master/README.md
Tools Catalogue	N/A	https://zenodo.org/communities/graspos-tools	N/A
Templates & Guidance Materials Catalogue	N/A	TBD at Q4 2024	N/A

Regarding the Tools Catalogue, since we have selected to implement it as a Zenodo community, no development of source code and no documentation was required. Finally, regarding the Templates & Guidance Materials Catalogue, this is the latest addition to the

GraspOS infrastructure. The need for this catalogue was identified through the work conducted in the context of D2.2[24], and GraspOS partners are currently in the process of implementing it. The first version is expected to be released in Q4 of 2024.

4.2. Data Interoperability & Access Layer (DIAL)

As mentioned, DIAL is more or less the union of the APIs of the data services federated in the GraspOS infrastructure. As a result, no separate code repository is provided for it. The following table contains links to the APIs of the GraspOS data services as well as the repositories that contain the code for the production of the respective data assets and the respective documentation websites.

Table 5 *GraspOS data services APIs, production code & documentation*

API	Data production workflow	Documentation
Assessment Protocol Registry: N/A	N/A	N/A
Assessment Portfolio Registry: N/A	N/A	N/A
BIP! DB: https://bip-api.imsi.athenarc.gr/documentation	https://github.com/athenarc/Bip-Ranker	https://github.com/athenarc/Bip-Ranker/blob/main/README.md
BIP! NDR: N/A	https://github.com/athenarc/bip-ndr-workflow	https://github.com/athenarc/bip-ndr-workflow/blob/main/README.md
OpenAIRE Graph: https://graph.openaire.eu/docs/apis/search-api/	https://code-repo.d4science.org/D-Net/dnet-hadoop	https://graph.openaire.eu/docs/
OpenCitations data: https://opencitations.net/index/api/v2	https://github.com/opencitations/index and https://github.com/opencitations/oc_meta	https://github.com/opencitations/index/blob/master/README.md and https://github.com/opencitations/oc_meta/blob/master/README

[24] GraspOS Deliverable 2.2: https://zenodo.org/doi/10.5281/zenodo.10475459

		E.md
ScholeXplorer: https://api.scholexplorer.openaire.eu/v2/ui/	https://code-repo.d4science.org/D-Net/dnet-applications/src/branch/master/apps/scholexplorer-api	https://scholexplorer.openaire.eu/documentation
PRISM: N/A	Metadata extraction through this link. Supports isolating books with PRISM record: https://www.doabooks.org/en/librarians/metadata-harvesting-and-content-dissemination	Generic documentation on how a publisher can join DOAB/PRISM: https://doabooks.org/en/publishers/documentation

4.3. Infrastructure Front-end UI

The following table contains the code repository, the current deployment, and the documentation of the Infrastructure Front-end UI.

Table 6 *Code, prototype, and documentation of the Infrastructure Front-end UI*

Component	Code repository	Current deployment	Documentation
Infrastructure front-end UI	https://github.com/athenarc/graspos-infra	https://graspos-infra.athenarc.gr/	https://github.com/athenarc/graspos-infra/blob/master/README.md

5. Conclusions

In this report, we have presented implementation details regarding the GraspOS infrastructure. The infrastructure is composed of a set of core components that facilitate the federation and discoverability of a set of open resources (data, tools, services, templates, and guidance materials) that can assist OS-aware RRA processes. The aim of the infrastructure is to pave the way for the policy reforms towards a responsible research assessment framework that takes into consideration Open Science.