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DELIVERABLE 5.2

Conceptual Design Report for ELI User Portal

Work Package #	WP5
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Abstract:
The ELI ERIC User Portal is main user's interface and entry point for the ELI ERIC Scientific Computing Data Management System. It is the system through which proposals for experiments are submitted. The collection of scientific and technical requirements for experiments initiates the implementation of scientific data workflows, relying on specific information collected and structured into multiple layers of metadata in line with the ELI ERIC's Data Policy and User Access Policy.

This deliverable gives an overview of the future capabilities and functionalities of the User Portal from an IT perspective, presenting the technology stack recommended for the future implementation of the Portal. Those have been conceived to meet the specifications of the workflow and processes for access defined within the framework of IMPULSE Task 5.1.

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List of Abbreviations

Abbreviation	Meaning
AAA	Authentication Authorisation Accounting
DMP	Data Management Plan
DOI	Digital Object Identifier
EC	European Commission
ELI	Extreme Light Infrastructure
ELI ERIC	ELI European Research Infrastructure Consortium
ELI-ALPS	ELI Attosecond Light Pulse Source Facility
ELI-NP	ELI Nuclear Physics Facility
ERIC	European Research Infrastructure Consortium
ERP	Enterprise Resource Planner
IaaS	IT Infrastructure as a Service
IDP	Identity Provider system
IMS	Integrated Management System
LMS	Learning Management System
MVP	Minimum viable product
PaaS	Platform as a Service
PI	Principal Investigator
SCDMS	Scientific Computing and Data Management System
SLA	Service Level Agreement
UO	User Office
UP	User Portal
UX	User Experience

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1 Scope of work

This deliverable provides a description of the conceptual design of the ELI ERIC User Portal, presenting both the capabilities and functionalities of the platform and the initial technology stack considered to address the requirements of the access workflow and processes identified within the framework of Task 5.1.

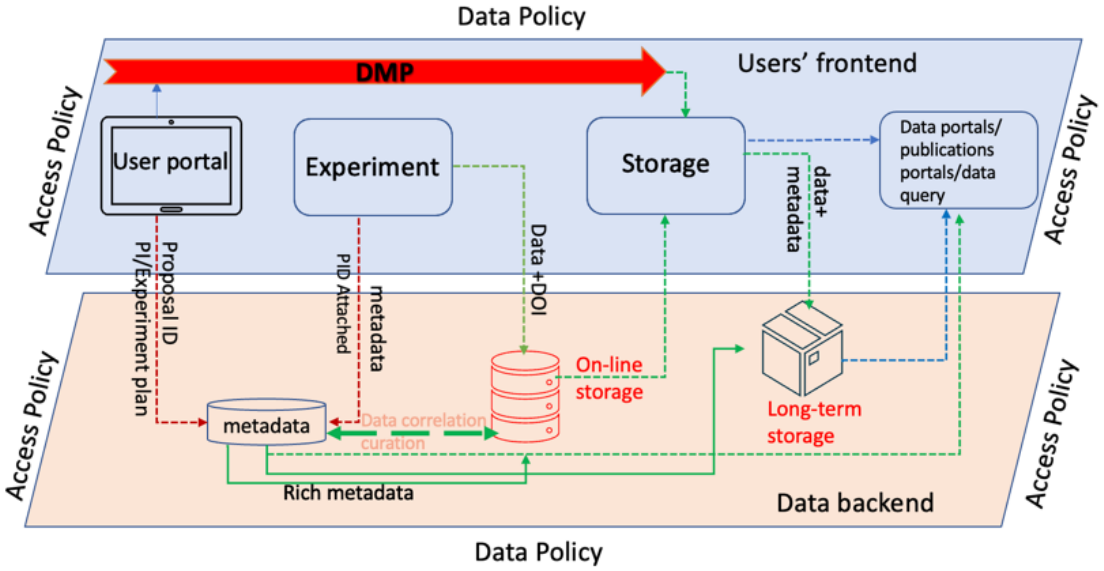

Figure 1 – ELI Users' Data Journey (SCDMS onboarding process)

The ELI ERIC User Portal[1] is the system through which proposals for experiments are submitted. The collection of specific scientific and technical requirements for experiments initiates the implementation of scientific data workflows of ELI's Scientific Computing and Data Management System (SCDMS), relying on specific information collected and structured into multiple layers of metadata in line with the ELI ERIC's Data Policy[2] and User Access Policy.

Figure 1 above gives an overview of the main data workflows underlying the 'Data Journey' of ELI's users, while **Figure 2** presents ELI ERIC's Scientific Computing and Data Management System Concept.

[1] https://up.eli-laser.eu/
[2] https://zenodo.org/record/6515903#.YqF3jRNBwUo

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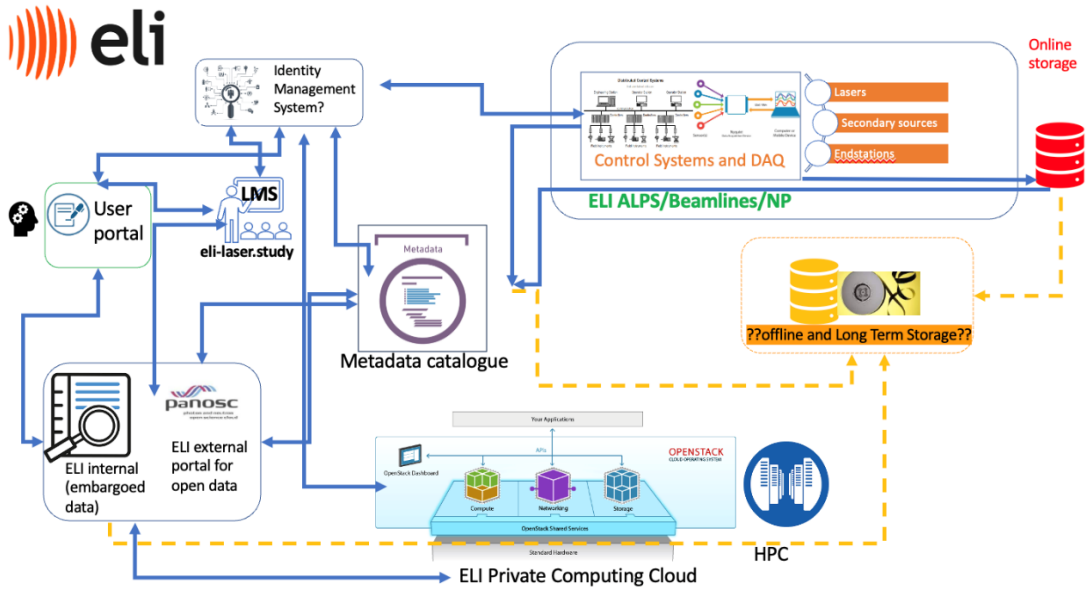

Figure 2 – ELI ERIC Scientific Computing and Data Management System Concept (SCDMS)

The portal is meant to integrate a collection of services and thereby provide users with a unified and integrated experience. To that aim, ELI's SCDMS system is developed as a modular, fault-tolerant and resilient system that follows the relevant IT industry best practices and standards. The technology stack was conceived to facilitate the controlled integration of new modules to support new features. The development of complex, monolithic[3] applications was avoided by selecting a scalable and flexible microservices development approach.

The integration process relies on a Central Identity Management System (the development instance is already used for the Learning Management System), which is able to integrate the existing Identity Management Providing Systems (IDP) existing at each of the ELI Facilities. The selected system[4] (available at https://aai1.eli-laser.eu) can be used by multiple systems of the organisation. It supports the future development and implementation of Single Sign-On mechanisms and is able to act as a central User Management Interface for the entire SCDMS.

The first step aims at integrating the User Office with the ELI ERIC Learning Management System[5] (LMS). The scope of this integration layer is to provide users selected for experiments to access the mandatory safety training. The integration aims at having the training content automatically assigned by the User Office managers to the PI Team, based on a unique User ID provided by the same ELI ERIC Central Identity Management System. This approach will harmonize the User Office Processes and integrates with the ELI ERIC Environmental Health and Safety training processes.

[3] https://articles.microservices.com/monolithic-vs-microservices-architecture-5c4848858f59
[4] https://aai1.eli-laser.eu/auth/realms/master/login-actions/authenticate?execution=b1fc45cd-fc93-4ef2-ab8e-45f796a49f21&client_id=security-admin-console&tab_id=FNmB0nX5byg
[5] https://eli-laser.study/

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The same User Identity provided by the Central Identity Management System will be used to allow users' access to experimental data based on the specific requirements collected from users during the experiment proposal and preparation process. The file cataloguing system receiving the metadata and the user profiles from the User Portal will allow users to access their experimental datasets, perform data operations and should allow them in the future to visualize scientific datasets and perform basic remote data analysis operations.

The development of SCDMS, starting with the ELI ERIC User Portal conceptual design, builds on the Access workflows and processes specified collaboratively by ELI ERIC, the ELI Facilities and the IMPULSE Project partners within the framework of Task 5.1 and on input provided by the other IMPULSE work packages, namely WP2 (T2.5 the Integrated Management System and ERP), WP5 (T5.6 – the Integrated Learning Management System).

The User Office workflow, as shown below in **Figure 3** forms the cornerstone of the User Portal Design and one of the key systems defining the roles and privileges assigned to users and personnel.

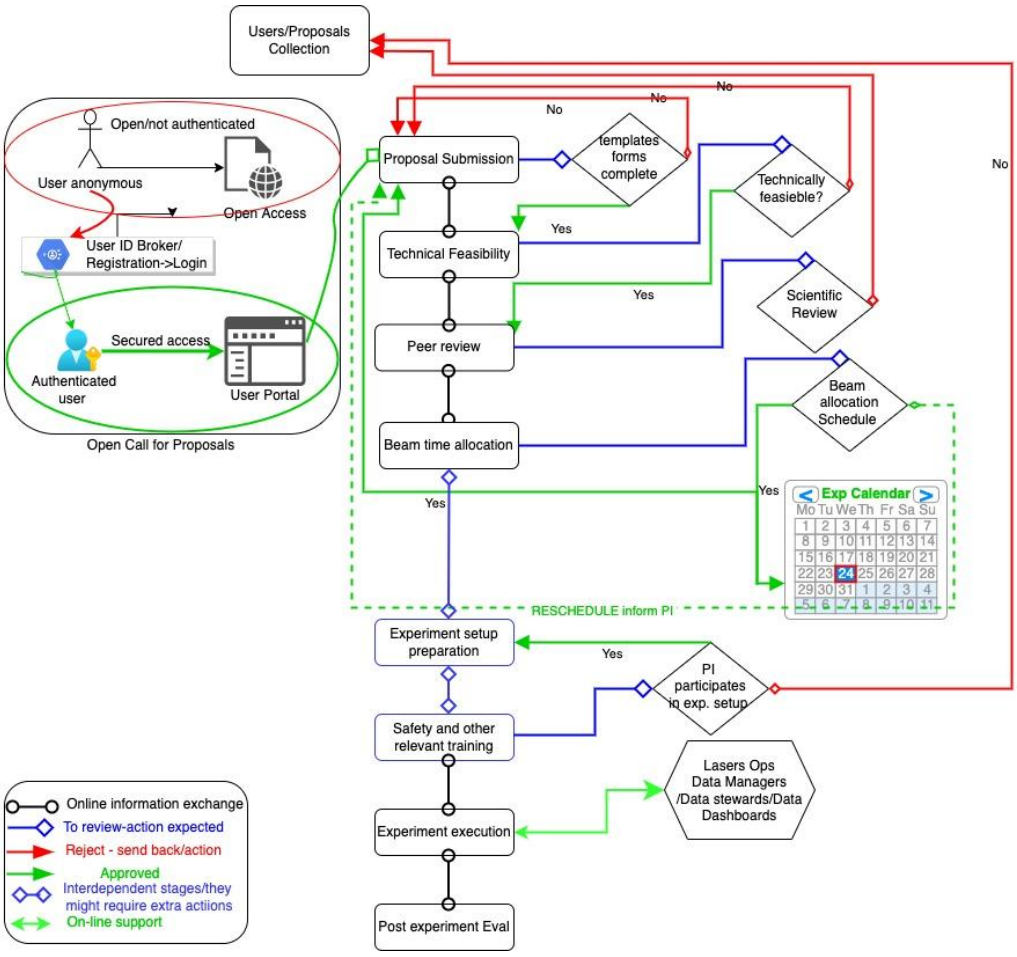

Figure 3 – Access workflow

The first version of the ELI ERIC User Portal was developed on that basis, having in mind it should primarily be the main user's interface and entry point for the ELI ERIC Scientific Computing Data Management System (SCDMS), but also have the capacity to evolve gradually

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into one of the elements of the Integrated Management System (IMS) interfacing with the ERP.

2 Conceptual Design of the User Portal – a microservices approach

The software architecture of the User Portal platform is based on the microservices approach. The platform's features and capabilities are divided into separate components, which can communicate between each other and the client through an API gateway and a message broker.

Compared to the traditional monolith solution, this option presents the following benefits:

- Improved maintainability through isolated services that can be developed and upgraded independently
- Easier customization thanks to decoupled components

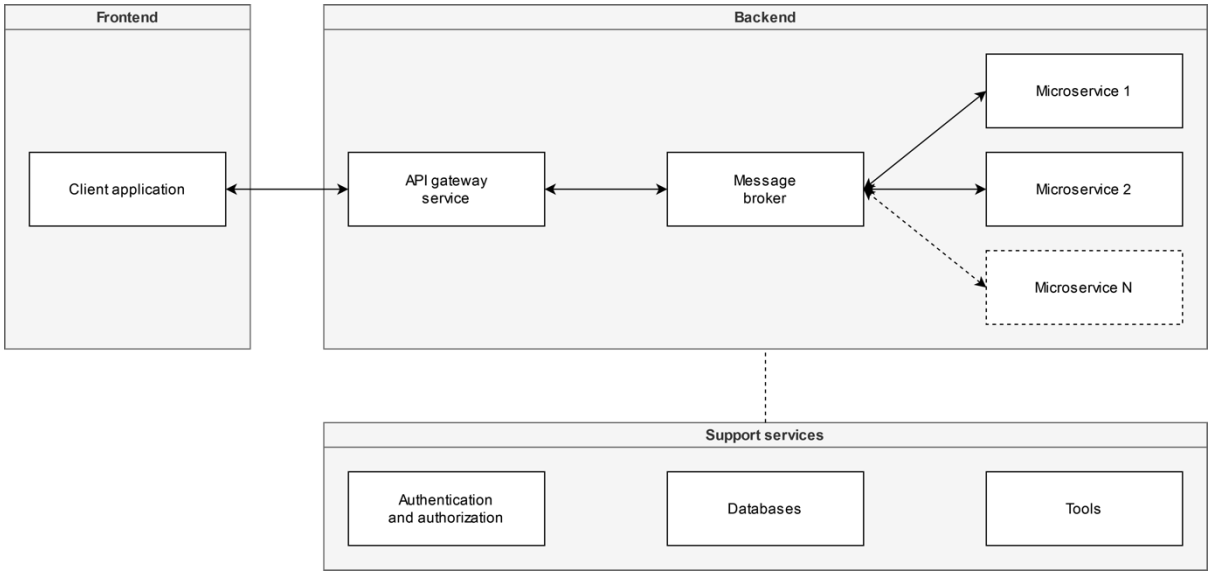

Figure 4 – User Portal Technical Conceptual Design Diagram based on microservices approach

The API gateway sits between the client(s) and services, performing a number of different functions, e.g., authentication and authorization delegation, request rate limiting, logging, and monitoring. In connection with the message broker, acting as a router to individual microservices, it replaces the traditional monolith backend application while keeping the original functionality and adding the previously mentioned benefits.

2.1 Software stack

For the development of the platform, TypeScript[6] has been chosen as the primary programming language for both the frontend and backend. As a superset of JavaScript, the essential component of modern frontend programming, it has also a proven track record in

[6] https://en.wikipedia.org/wiki/TypeScript

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backend software development. Such flexibility combined with it being a common item in the skill-set of most web developers represents a strong argument to make it the favorite candidate for the development of the platform.

2.2 Frontend

The frontend client will be developed in Svelte[7], and more specifically the SvelteKit[8] framework. Compared to similar competing frameworks, it can achieve similar results with less boilerplate, smaller data bundle for the client and improved overall reactivity.

The technical sustainability of the development will be insured by the fact that SvelteKit is one of the web frameworks with the most satisfying development experience for developers[9] in the JavaScript ecosystem and a very promising community trend[10]. It provides a low entry level for new web developers and easy onboarding for developers with experience in other frameworks, allowing us to extend the support community and continuously improve the frontend of the platform.

2.2.1. Design system

The client interface will be using IBM's Carbon Design System[11], which has previously been adopted in other ELI ERIC projects, e.g., the LMS and the development of the ELI ERIC training catalogue[12]. The system provides extensive guidelines for layout composition and component building, and is accompanied by a component library[13] in Svelte.

2.3 Backend

The backend solution should be built with one of the more conventional server-side Node.js frameworks, not being tied to any User Interface (UI) library. As a potential option, NestJS[14] is a very versatile candidate that could accommodate all current and future requirements, which is going to be further considered and evaluated by the development team.

The technology stack. We aim at having a limited collection of software technologies and/or development frameworks used for the user portal. This way we avoid building heterogeneous development environments which can become less inflexible and not sustainable.

[7] https://kit.svelte.dev/docs/introduction
[8] https://kit.svelte.dev/
[9] https://2020.stateofjs.com/en-US/technologies/front-end-frameworks/
[10] https://risingstars.js.org/2021/en#section-framework
[11] https://www.carbondesignsystem.com/
[12] https://eli-laser.study/
[13] https://github.com/carbon-design-system/carbon-components-svelte
[14] https://nestjs.com/

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2.3.1. Authentication

The user authentication will be provided by an external Keycloak instance, that can act both as an identity proxy, allowing the users to authenticate using their scientific identity providers, like UmbrellaID[15] or ORCID[16] but also provide local or ELI-specific identity providing solutions, such as local Keycloak users' databases, local ELI ERIC Active Directory[17] services or local LDAP[18] systems which might be developed locally by the ELI ERIC IT Department.

The Identity Management System is one of the key services provided by ELI ERIC as part of the overall IT Infrastructure services.

2.3.2. Authorization

As part of the Authentication, Authorization and Accounting process, the platform requires an access control layer for the management of user and machine-resource permissions. This decision is closely tied to the selected backend, however, an up-and-coming Oso[19] library is the solution considered for the current development process.

AAA will follow the same standard selected for all the other systems of the Integrated Management System of ELI ERIC. Roles and accounts with special permissions will be developed by the development team according to the documentation and definitions provided by the Task 5.1 working group, respecting the standards and the policies of the organization.

2.3.3. Accounting

As part of the accounting process, all the above-mentioned modules, services and microservices will be configured to store the information generated by each authentication transaction offering full support for the IT Teams to troubleshoot the application, identify and fix issues. Most importantly, it is the part of the system that is used to provide authenticity and trustworthiness for the User Portal operations, including the collection of all necessary activity logs required by GDPR and/or IT Security operations.

As part of the same process, an automated error logging service will provide insights into the implementation of new features and occurring platform bugs. Sentry[20] provides an out-of-the-box solution, covering both frontend and backend with detailed reports, error grouping, code repository integration and email notifications. A self-hosted option is available.

[15] https://www.umbrellaid.org/
[16] https://orcid.org/
[17] https://docs.microsoft.com/en-us/windows-server/identity/ad-ds/get-started/virtual-dc/active-directory-domain-services-overview
[18] https://cs.wikipedia.org/wiki/LDAP
[19] https://www.osohq.com/what-is-oso
[20] https://sentry.io/welcome/

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3 Risk Management and the CMMI approach

The ELI ERIC ICT Department uses a common standard, a process improvement framework, aiming at supporting software development processes and activities. The selected standard, the Capability Maturity Model Integration (CMMI), is a common set of practices used by organizations to streamline process improvement, encouraging a productive, efficient culture that decreases risks in the development of software products, and services development.

In the context of the User Portal development, the CMMI approach includes 2 major areas that were addressed during the last year:

- The first area, mainly part of the T5.1 working group, focused on the development of the processes, building capabilities and defining the goals and objectives in close correlation with the ELI ERIC organizational concept. As a direct result, clear processes have been defined, leading to reliable user portal workflows and processes for the software development team, thus reducing the risks of the software development project.
- The T5.2 working group, which is focusing on defining the software platform and managing the development and integration of the software modules, has also developed capabilities and, as a direct result of their involvement in both T5.1 and T5.2 activities, has already, independently, tested modules and functionalities as part of the initial research. This reduces risks associated with the technology stacks, existing technologies or even design feasibility risks.

3.1 CMMI Maturity assessment levels. Preparing the workflows and organizational support for the platform development.

The CMMI Maturity Assessment is a part of the framework evaluating the maturity of the processes, which is a key factor in the success of a software development project. The collection of practices streamlined the development of the processes and was used to structure the activity of the teams engaged in the definition of the processes and workflows of the software platform. Furthermore, the same framework is used to identify and support the development and integration of the necessary management support mechanisms and roles, together with the development of relevant management controls and performance indicators that will be used both for structuring and supporting a reliable development of the platform.

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3.2 CMMI. The capabilities levels driving the software development and risk analysis

CMMI capabilities levels have been used to build and evaluate the capabilities and the readiness of the teams involved in the development process.

In this context, the IMPULSE Project T5.1 has developed all necessary processes and workflows to support the software development activities. At the same time, the software development team, in parallel, has developed capabilities by testing modules and functionalities of different systems and solutions, gaining experience and a clear understanding of the scope and overall objectives.

In this concept, starting from Capability Level 0, where the performance is inconsistent as the processes are not defined or information is not accurate, using the existing processes used by the User's Office Teams of the ELI Facilities and the experience and expertise of the IMPULSE Project Partner facilities, Elettra and HZDR, we have progressively structured the T5.1 activities and, based on the CMMI framework, we went through all the stages of the framework, from Capability 0 to Capability Level 3. These processes and activities have provided a clear focus and clear understanding of the objectives for the teams in correlation with the ELI ERIC Integrated Management System standards.

Building capabilities include two stages which were addressed in parallel:

- **Building user office workflows,** in other words the business process requirements, which were developed following the basic principles of the ELI ERIC Integrated Management System and in compliance with the relevant policies of the organization;
- **Building software/development team capabilities**, which is part of the preparatory work and tests performed by the team.

The following CMMI capabilities are describing the development process:

1) **Capability Level 0 – Incomplete**: Inconsistent performance and an "incomplete approach to meeting the intent of the practice area". In ELI ERIC's case, for the development of the User Portal, the team was part of the T5.1 activities and engaged in collecting, defining, structuring, and understanding the requirements of the platform.
2) **Capability Level 1 – Initial**: the phase where organizations start to address performance issues in a specific practice area, but there is not a complete set of practices in place. This level was insured by several smaller-scale projects developed by the team. These projects, though addressing some of the ELI ERIC's challenges, have been focusing on increasing and building the necessary standards supporting the consistent development of the ELI ERIC IT Environment. (e.g. the initial implementation of the test Moodle platform and with Keycloak identity management system, the development of the Invenio and ICAT file catalogs with a standalone Identity Management platform, all addressing ELI ERIC Specific challenges and used to

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develop standards and objectives which are now becoming a practice for the ELI ERIC IT Management System).

3) **Capability Level 2 – Managed**: Progress is starting to show and there is a full set of practices in place that specifically address improvement in the practice area. This stage is achieved by the team after launching the ELI ERIC Integrated LMS in production, the team has now the capacity to understand the organizational standards, to properly understand the service level.

Capability Level 3 – Defined: There's a focus on achieving project and organizational performance objectives and there are clear organizational standards in place for addressing projects in that practice area.

3.3 Risk and risk mitigation strategy

Risk management is a permanent part of the activities of the ICT Group and is included in the CMMI framework used to prepare the development processes.

The typical internal and external risk sources include the following risks, which were partly mitigated and addressed:

a) **Uncertain requirements** – the risk was addressed from the start of the project and is part of the activities of the T5.1 working group. This category of risk was mitigated both in terms of workflow specific requirements as well as from the perspective of the technical requirements or technology stack.

b) A common risk in software development projects, the **risk of unprecedented efforts** (i.e., estimates unavailable), was also mitigated: the team has already tested and benchmarked similar projects, and the partners already performing users' experiments have already shared details about the development efforts required to build and maintain a User Portal platform.

c) **Infeasible design** – this risk is now addressed in the design and architecture stage. It is a risk that is evaluated step by step by both Task 5.1 and T5.2 teams as the teams are step by step developing and testing the platform. This allows the design to be optimized and improved, as the application is based on microservices that can be easily upgraded, improved and even changed without impacting the overall performance of the platform.

d) **Competing quality attribute requirements that affect solution selection and design** – this risk will be always present, both in the design and operations of the platform as some of the workflows, some of the controls and KPIs might evolve and adapt based on specific users' or organizational requirements. In this context, a periodic risk assessment will be conducted as part of the quality control process and, based on the risk analysis, the team will prepare future upgrades to the platform.

e) **Unavailable technology** – Though this risk was already addressed and the required technologies exist, depending on future requirements of the users' and User's Office management teams, the risk might be present in the context of the future upgrades of the workflows, this risk will also be periodically assessed and reported.

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f) **Unrealistic schedule estimates or allocation** of resources – this is not currently a risk: the team has the experience; the development and the team will constantly increase and the management team will commit more resources to streamline the development. The platform is going to be part of the ELI ERIC Integrated Management System thus the platform development process and progress are periodically evaluated and reported.

g) Disruptions to the continuity of operations – this risk is constantly and periodically evaluated as there are many factors impacting the continuity of operations. The main risk resides in the readiness and availability of the IT infrastructure hosting the services. In this context, to address this risk, all developments are platform-independent, able to migrate to, and from, any type of IT infrastructure, physical virtual or cloud (IaaS, PaaS, Physical on-prem).

h) Regulatory constraints (e.g., security, safety, environment) – this is a risk during the entire lifecycle of a software project, regulatory and compliance aspects include topics like GDPR, legal terms and conditions for users of the platform, together with the deterrence, detective, corrective and preventive controls and activities of the ELI ERIC ICT Management Systems. This risk is periodically evaluated and is part of the quality control as well as part of the overall ICT Compliance process of the organization.

4 Business continuity and reliable development environment

As a common standard of the ELI ERIC IT Systems, the development team is going to use a unique quality standard for all systems. This standard sets the minimum requirements in terms of:

- High availability of the infrastructure supporting the services, in many cases is covered by the fact that we are using hybrid setups combining cloud resources and on-premise, physical infrastructure.
- Resilience and fault tolerance is also part of the infrastructure layer but, at the same time, the software development teams are approaching these aspects from the software design point of view, which is why the team is using two distinct environments:
    - **A staging environment**, or a development where tests are performed before applying changes to the production environment. This layer is a replica of the production system, with access to the same databases, same kind of storage or a replica of the storage volumes used in production.
    - **A production environment,** which is used for and by the users and stakeholders, is under strict SLAs and is part of the daily IT Operations. For this layer, the team sets in place alerting monitors the relevant KPIs and schedules operations and change management processes according to the ELI ERIC IT Operations rules and procedures. Both environments are governed by the ELI ERIC ICT Management System rules and principles.

In the context of the ELI ERIC User Portal development process, the team has in place:

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4.1 The staging environment

This development layer will be reflecting the current status of development and will be further maintained for testing purposes, upgrades or other preparatory work, without impacting the production environment. All merged branches to the development branch of the code repository and marked as release candidates will be deployed here. The primary purpose of this server will be testing new features, bug hunting and simulation the production deployment process.

- Staging Keycloak instance for tests: there are already two instances available, one ready for production, the other used to test and evaluate Identity Providers like UmbrellaID or ORICID. Most importantly, the test instance is used to test specific security policies and test specific users' roles[21] and permissions in the context of different applications.
- A staging emailing service is also planned to be provisioned soon as there is a test instance allowing the team to perform tests for alerts and reports. This allows tests to be performed independently from the email system used by the organization.
- Staging object storage instance: it allows the team to perform tests, without depending on the production storage, which might not be as flexible as the test instance.
- Staging data management plan platform instance[22] based on the open Data Stewardship Wizard: the team is evaluating the possibility of having a single instance controlling the versions and updates of the experiment Data Management Plans. This ensures versioning and traceability of changes and updates across the platform.
- Staging error logging service: it is crucial for the reproducibility of any bugs and errors in the platform.

4.2 Production environment

The production environment will be launched once an MVP instance of the User Portal platform stack is ready for tests. It should host latest version of the software on the main branch of the code repository that has been previously tested on staging servers.

- Production Keycloak instance facilitating the authentication and authorization of the ELI ERIC users, integrating the scientific identity providers accepted by ELI ERIC. (UmbrellaID and ORCID).
- Production emailing service, the instance is using the ELI ERIC official email services, sending emails using the agreed email domain. (emails @eli-laser.eu domain will be used and configured to support the production environment). At this stage, the mailing service and the service account used by the portal will be included in the monitoring services and the operations team will be informed.
- Production object storage instance, this is already addressed and is part of the ELI ERIC ICT Infrastructure. Dedicated file storage will be made available respecting the requirements and standards of the organization.
- Production data management plan platform instance for the production environment.

[21] https://docs.oracle.com/cd/E19798-01/821-1841/6nmq2cpjd/index.html
[22] https://dsw1.eli-laser.eu/dashboard - based on the https://ds-wizard.org/

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- Production error logging service, making sure all logs are collected and made available for the operations team.
- Production data backups service, backing up the forms and other data managed for the users of the platform.
- Production analytics and reporting services, generating the necessary analytics and reports for the User Office managers.

5 Current status and next steps

At the time of submission of this deliverable, the conceptual design project is completed, and the team is evaluating the technology stack, and the development frameworks and working on defining the final software architecture of the solution.

The development progress and activities are tracked and managed via the ELI ERIC Jira Atlassian, and a dedicated GitHub space for software versioning control.

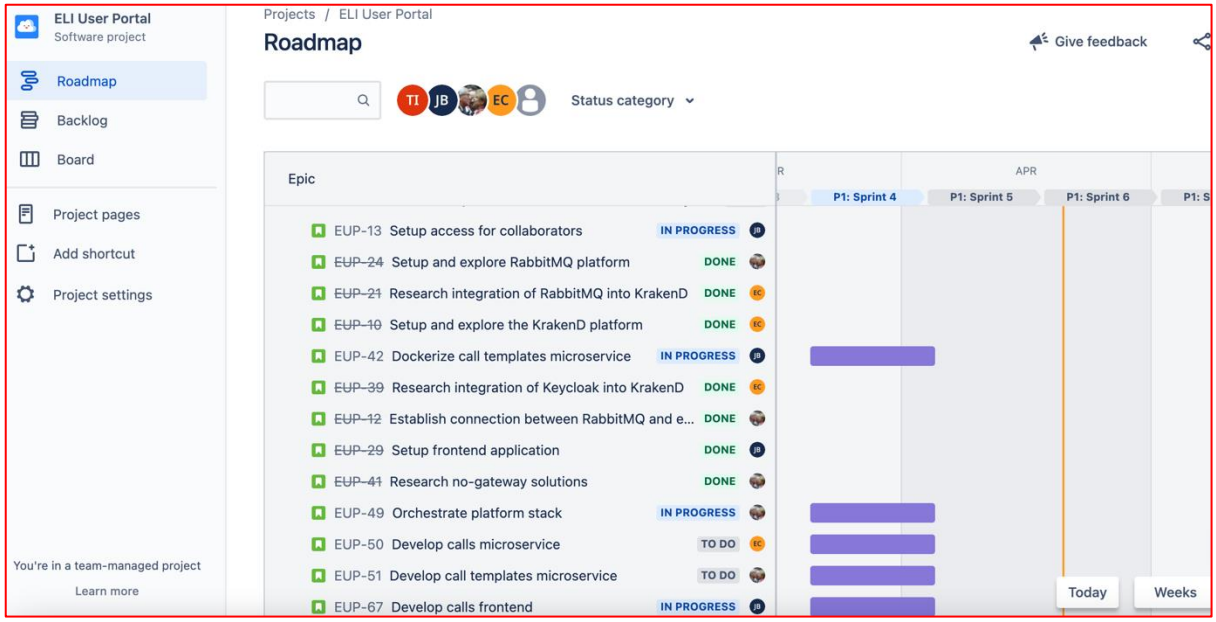

Fig 5. – Jira Service Management, an activity tracker for the User Portal Development

As a next step, the team will be presenting in the following month the final software architecture, and all details related to the technology stack tests and progress. Based on the architecture, the team will present a Software Project Development and Testing plan and schedule the activities so that each microservice will be tested both independently and integrated as part of the User Portal Platform.

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