Project Title	European Science Cluster of Astronomy & Particle physics ESFRI research Infrastructure
Project Acronym	ESCAPE
Grant Agreement No	824064
Instrument	Research and Innovation Action (RIA)
Topic	Connecting ESFRI infrastructures through Cluster projects (INFRA-EOSC-4-2018)
Start Date of Project	01.02.2019
Duration of Project	42 Months
Project Website	www.projectescape.eu

ESCAPE PROGRESS REPORT FEB 2019 - JAN 2020

Work Package	WP 1 - Management, Innovation, Networking and Dissemination (MIND)
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Due Date	14 February 2020
Date	23 February 2020
Version	0.1

Dissemination Level

X	PU: Public
	PP: Restricted to other programme participants (including the Commission)
	RE: Restricted to a group specified by the consortium (including the Commission)
	CO: Confidential, only for members of the consortium (including the Commission)

Versioning and contribution history

Version	Date	Authors	Notes
0.1	22/02/2020	Jayesh Wagh (CNRS-LAPP)	Near complete draft
0.2	24/02/2020	Kay Graf (FAU), Mark Allen (CNRS-CDS)	Minor updates
0.3	24/02/2020	Jayesh Wagh (CNRS-LAPP)	Final draft

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Project Summary

ESCAPE (European Science Cluster of Astronomy & Particle physics ESFRI research infrastructures) addresses the Open Science challenges shared by ESFRI facilities (CTA, ELT, EST, FAIR, HL-LHC, KM3Net and SKA) as well as other pan-European research infrastructures (CERN, ESO, JIV-ERIC, EGO-Virgo) in astronomy and particle physics. ESCAPE actions are focused on developing solutions for the large data sets handled by the ESFRI facilities. These solutions shall: i) connect ESFRI projects to EOSC ensuring integration of data and tools; ii) foster common approaches to implement open-data stewardship; iii) establish interoperability within EOSC as an integrated multi-probe virtual research environment for fundamental science. To accomplish these objectives ESCAPE aims to unite astrophysics and particle physics communities with proven expertise in computing and data management by setting up a data infrastructure beyond the current state-of-the-art in support of the FAIR (Findable, Accessible, Interoperable and Reusable) data principles. These joint efforts are expected to result into a data-lake infrastructure as cloud open-science analysis facility linked with the EOSC. ESCAPE supports already existing infrastructure such as astronomy Virtual Observatory to connect with the EOSC. With the commitment from various ESFRI projects in the cluster, ESCAPE will develop and enrich the EOSC portal with a dedicated catalogue of open access data and open source analysis software. This catalogue will provide researchers across the disciplines with new software tools and services developed by the astronomy and particle physics community. Through this catalogue, ESCAPE will strive to cater researchers with consistent access to an integrated open-science platform for data-analysis workflows. As a result, a large community “foundation” approach for cross-fertilization and continuous development will be strengthened. ESCAPE has the ambition to be a flagship for scientific and societal impact that the EOSC can deliver.

Executive summary

One year after the H2020-ESCAPE project kick-off on 1 February 2019, this report provides details on the scientific and technical activities carried out in the first year of the project from 1 February 2019 – 31 January 2020 in line with the project grant agreement. This document will serve as a reference document for the ESCAPE general assembly members as well as the ESCAPE external expert advisory board members to review the project progress in the first year.

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1. Introduction

The European Open Science Cloud (EOSC) is an initiative by the European Commission (EC) to provide researchers, and science and technology professionals the means to collaborate on some of the world's most pressing societal challenges like never before. EOSC aims to become Europe's trusted virtual environment for 1.7 million European researchers and 70 million professionals in science, technology, the humanities and social sciences to store, manage, analyze and re-use data for research, innovation and educational purposes, as well as to support EU science in its global leading role.

European Science Cluster of Astronomy & Particle physics ESFRI research infrastructures (ESCAPE) brings together seven ESFRI facilities (CTA, ELT, EST, FAIR, HL-LHC, KM3NeT, SKA), two pan-European organizations (CERN, ESO), an ERIC (JIV-ERIC) and a French-Italian private Consortium (EGO-Virgo) in astronomy and particle physics research domains to support the EOSC implementation. These organizations and research infrastructures have aligned challenges of data-driven research, with demonstrated capabilities in addressing various stages of data workflow and concerned with fundamental research through complementary approaches. ESCAPE work programme is organized in following seven work packages (WPs) to implement a functional link between the astronomy, astroparticle physics and particle physics community and EOSC.

- **WP1 Management, Innovation, Networking and Dissemination (MIND)** supports the networking with various EOSC stakeholders (EOSC governance, e-infrastructures, other H2020 projects, policy bodies, industries); implement the connection between EOSC and the ESCAPE RIs management boards. Operating a central competence support desk for application of FAIR-oriented standards and methods within the ESFRI facilities and providing the technical coordination and the scientific internal validation of the WPs results.

- **WP2 Data Infrastructure for Open Science (DIOS)** will design, implement, and operate a prototype data lake – a federated data infrastructure that will form the basis of an open access data service for the ESFRI projects within the ESCAPE cluster. It will propose such a solution as a key component of a future EOSC framework.

- **WP3 Open-source scientific Software and Service Repository (OSSR)** supports an open environment to guarantee cross-fertilisation and to develop community-specific software and data services that will be exposed under the EOSC catalogue of services under the *FAIR* principles.

- **WP4 Connecting ESFRI projects to EOSC through VO framework (CEVO)** plans to make the seamless connection of ESFRI and other astronomy and astroparticle research infrastructures to the EOSC through the VO, actively contributing to the setting up of the EOSC services.

- **WP5 ESFRI Science Analysis Platform (ESAP)** will focus on defining and implementing a platform-service for data analysis into EOSC and tailored to the requirements and the user needs of each of the ESFRI and other RI member of ESCAPE. It will be part of the EOSC catalogue.

- **WP6 Engagement and Communication (ECO)** develop outreach material and support actions. Involve citizens directly in knowledge discovery with ESCAPE and the ESFRI facilities, improving transparency of the scientific process.

- **WP7 Ethics requirements** sets out the 'ethics requirements' that the project must comply with.

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ESCAPE will deliver a list of services to ensure that after the end of the project there is a clear pathway and sufficient momentum to take forward the full involvement of the ESFRI projects in the European Open Science Cloud as presented in the schematics below.

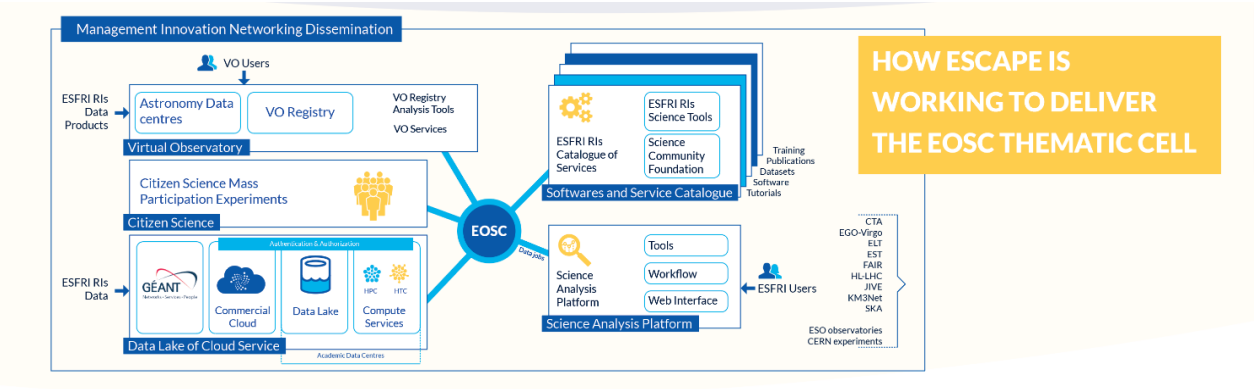

Figure 1: ESCAPE contributions to EOSC through its workprogramme

In this report we present a summary of technical activities to date towards the achievement of these goals. It is based on the inputs received from all the work package leads describing the activities carried out in the first year of the project and plans for the upcoming six months until the first periodic review in September 2020. This report seeks to identify interfaces between technical work packages and provide a global overview of the project activities to the ESCAPE general assembly members and the ESCAPE External Advisory Board members for their inputs.

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2. Project objectives

This chapter of the report lists the specific project objectives listed under the grant agreement and the work carried out during the first year of the project (1 February 2019 – 31 January 2020) towards the achievement of each listed objective.

2.1 WP1 - Management, Innovation, Networking and Dissemination (MIND)

WP1 MIND deals with the overall governance and management of the project. This involves support to the consortium members on administrative, financial as well as legal aspects of the grant agreement. WP1-MIND also reaches out to the other H2020 projects as well as external institutes and organizations with similar objectives for potential collaborative opportunities. WP1 MIND has a pivotal role of overall project management, innovation, networking and dissemination. The ESCAPE management support team has organized itself in two task groups. The task group 1 addresses governance, coordination and management whereas task group 2 addresses dissemination, innovation and networking. WP1 MIND is led by CNRS-LAPP with support from CERN, FAU, CNRS-CDS, NWO-I-ASTRON and OU. In this section we have listed the objectives that were addressed during the first year of the project

- ESCAPE management support team (E-MST) has been setup. It now includes the coordinator, a project manager, a technical coordinator, a communications officer and a financial controller. The ESCAPE a technical coordinator will formally join the E-MST by 26 February 2020.
- ESCAPE encompasses eight ESFRI Research Infrastructures (RI). The members of the ESFRI RIs' management boards were consulted to define ESCAPE view on European Open Science Cloud (EOSC) concept implementation for the ESCAPE concerned domains. These consultations have resulted in the ESCAPE position statement that sets out the current views and expectations of astronomy and particle physics partners in ESCAPE about EOSC.
- The chairs of the ASTRONET, APPEC, NuPECC and ECFA consortia together with representative from ESA have been formally appointed as the ESCAPE External Expert Advisory Board members.
- E-MST has also been very actively exchanging with other EOSC cluster projects EOSC-Life, SSHOC, ENVRI-FAIR and PANOSC. E-MST has also been representing the consortium at the various international events addressing the implementation of EOSC, both under the initiative of EC and ESFRI boards. Full list of these events is available in chapter 10 of this report.
- E-MST has so far organized six ESCAPE executive board meetings with participation of all the workpackage leads, the project manager and the Chair of the General Assembly (E-GA). These meetings have been instrumental to track the project progress in terms of technical objectives, recruitments as well as steering the interfaces with other EOSC stakeholders.
- Three of the ESCAPE executive board members are also contributing to the EOSC architecture and FAIR working group.
- Over the year E-MST has organized two major collective events, the ESCAPE kick off meeting in February 2019 and ESCAPE progress meeting in February 2020. These events brought together not only the consortium members but also external participants from other EOSC stakeholder projects, members of EOSC governance as well as policy officers from the European Commission.
- The ESCAPE coordinator has represented the ESCAPE consortium and the vision of the ESCAPE scientific community in dedicated high-level consultation meetings with the EC officers, the ESFRI EOSC-Task Force, EOSC secretariat and has taken role in the EOSC-hub scientific strategy board.

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2.2 WP2 – Data Infrastructure for Open Science (DIOS)

WP2 DIOS will design, implement, and operate a prototype data lake – a federated data infrastructure that will form the basis of an open access data service for the ESFRI projects within the ESCAPE cluster.

- A Data Lake prototype

In the first 6 months of the reporting period, WP2 defined the architecture of the data lake based on the needs of the ESFRIs in terms of data management according to FAIR principles. We went through the existing technologies from different European projects and the ESFRIs themselves and understood if and how they would be suitable for implementing building blocks of the architecture's reference implementation. The architecture document and implementation plan was delivered in September 2019 and the implementation of the data lake pilot started after that. The pilot data lake relies on services provided by the data centres of WP2 partners and orchestrates them through a common service layer for all ESFRIs.

- Data Preservation.

The pilot data lake includes large data centres with experience in long term bit preservation on archival media, such as INFN-CNAF, SURF-SARA, IN2P3-CC, CERN, PIC. The data lake includes archive storage endpoints from some of those data centres and we plan to include them all in the next period. WP2 started a discussion about self-certification of such data centres for long term digital preservation and a dedicated workshop has been organized in March to discuss the next steps. Some centres already went through the certification process.

- Integration

The reference implementation of the data lake prototype is leveraging as much as possible the technologies developed in the context of other European projects. Examples are: the File Transfer Service and Rucio for data transfer and orchestration as part of the XDC project, the dCache, StoRM and EOS storage technologies also part of the XDC project. IAM from Indigo-Datacloud and part of EOSC-Hub for Authentication, Authorization and Identity management. In addition benefits from technologies developed and used in the context of the ESCAPE ESFRIs, such as XCache for caching and Hammercloud for commissioning. Finally, WP2 relies on services for network monitoring deployed in the context of WLCG in collaboration with GEANT and plans in the next phase to liaise with PRACE for the integration of HPC machines to process data stored in the data lake.

- Cooperative actions at regional and international level

Different implementations of the data lake will be deployed and operated by the ESFRIs at the end of the project, for their specific needs. The communities will decide which of the services they will retain from the reference implementation. To achieve a high degree of flexibility, WP2 is putting special attention in documenting[1] the process and providing examples and tutorials for the ESFRIs with respect of the data lake implementation. ESCAPE WP2 liaises with other organisations such as the

[1] https://wiki.escape2020.de/index.php/WP2_-_DIOS

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EGI foundation for specific services and plans to broaden the scope of collaboration to other science cluster projects.

- Computing interface and scalability

WP2 partners are prototyping a content delivery and caching layer based on the XCache technology to integrate compute resources with the data lake. The technology was demonstrated to provide the needed functionality and we are currently testing its scalability. The content delivery layer will allow to facilitate data processing from compute resources inside the data lake but also to integrate storage-less sites, including cloud resources and HPC centres. Processing data from the data lake will be the focus of the activity in the next period.

- Industrial and commercial involvement

The data lake architecture was designed to rely on open source protocols such as HTTP/WebDav that will allow integrating commercial storage providers. At the same time, the content delivery model is conceived to be deployed also in the proximity of cloud compute resources. Therefore the foundations of Industrial and commercial involvement were built in the prototype. In the future periods, after demonstrating computing interface and scalability (see above) we will integrate commercial resources.

- Skills

WP2 partners took the opportunity during the WP2 workshop in July 2019 to have hands-on sessions for disseminating technical knowledge of the components and the APIs. They intend to do the same in future events. They organized also topical tutorials such as the SWAN demo in October 2019. They rely on events organised by communities we collaborate with for training and dissemination on specific aspects and components. For example we participate and advertise Rucio coding camps and AAI hackathons.

2.3 WP3 Open-source scientific Software and Service Repository (OSSR)

The specific goals and objectives of the ESCAPE work package 3, the Open-source scientific Software and Service Repository (OSSR) are to:

1. Support a community-based approach for continuous development, deployment, exposure and preservation of domain-specific open-source scientific software and services in the global context of the EOSC catalogue of services;
2. Enable open science interoperability and software re-use for the data analysis of the ESCAPE ESF/RI projects based on *FAIR* principles;
3. Create an open innovation environment for establishing open standards, common regulations and shared software libraries for multi-messenger/multi-probe data.

They reflect the general ESCAPE objectives. The goals are defined by the deliverables and milestones of the work package.

To achieve the objectives of WP3, the work package project plan was set-up including the consensus and input of all 19 work-package partner institutes.

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The organisational structure is following the five tasks defined in the DoA, the roles of the partners and the collaborative environment have been defined and established. Each task has a dedicated task leader. All task leaders form a group with regular meetings to plan and coordinate the activities in the work package.

The aims of the tasks, following the objectives, have been defined and the work in the tasks started (see Sec. 1.2):

- *Task 3.1: Management Activities, Policy and Support Actions (MAPS)*
  The transversal activities on management, policy and support for OSSR.
- *Task 3.2: ESFRI Software and Services Collection (ESSC)*
  Collection of software, evaluation and exploitation of common practices in software development, maintenance and distribution.
- *Task 3.3: Common Approaches: Software and Services (CASS)*
  Sharing existing solutions and fostering joint development of new tools for specific analysis, simulation and processing tasks.
- *Task 3.4: Foundation of Competence for Software and Service Innovation (COSSI)*
  The creation of a team of scientists from different ESF/RIs who will investigate new, innovative approaches to data analysis, exploring machine-learning and deep-learning techniques with a special focus on the multi-messenger approach.
- *Task 3.5: Repository Implementation and Deployment (RIAD)*
  Implementation of a trusted digital repository to integrate open-source scientific software and services developed by ESFRI in tasks 3.2-3.4 and integration of this repository in the EOSC catalogue of services.

For an efficient organisation of day-to-day work in an open knowledge-sharing environment, focus groups have been successfully established. The focus groups work community-driven on most important aspects of implementing the projects' objectives, currently on the collection of the community software, the technical implementation of the OSSR repository, innovative workflows, and common approaches to CORSIKA[2]. The focus of those groups will change following the actual goals in the respective phases of the project. The work carried out is detailed in Sec. 0.

The deliverables and milestones as defined in the DoA are appropriate to follow the progress of the work package as well as the implementation of the objectives. A key indicator will be the number of software and services by ESFRI made available under the EOSC catalogue using *FAIR* principles – this indicator will become available in the next reporting period with the software list gathered in D3.2.

During the reporting period, no milestone and one deliverable were finalised and 29 meetings scheduled, including a first OSSR workshop. To foster the open development environment and knowledge sharing, appropriate IT services (mailing lists, meeting server, cloud server, chat server and wiki server) have been set up to share all relevant information (meeting agendas, presentations, minutes of meetings, etc.) with all partners.

2.4 WP4 Connecting ESFRI projects to EOSC through VO framework (CEVO)

The CEVO objectives are all focused on making the seamless connection of ESFRI and other astronomy research infrastructures to the EOSC through the Virtual Observatory framework. The status of the three high-level objectives of the work package are provided below.

[2] https://www.ikp.kit.edu/corsika/index.php

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- Assess and implement the connection of the ESFRI and other astronomy Research Infrastructures to the EOSC through the Virtual Observatory framework.

WP4 partners have undertaken the first steps to map the Virtual Observatory (VO) framework to the EOSC. This has involved engagements with EOSC in order to assess the various options and approaches for connecting the existing and operational VO framework into EOSC, with a specific collaboration with EUDAT. The initial results of improved and renewed integration of the VO registry of resources into EUDAT B2FIND have been very efficient and positive. This early implementation provides a concrete example which can be assessed with the aim of providing feedback to EOSC, and it will help in the preparation of advice for the ESFRI and RI partners about connecting to the EOSC via the VO framework.

- Refine and further pursue implementation of FAIR principles for astronomy data via the use and development of common standards for interoperability including the extension of the VO to new communities.

The work in the first period has started with a lot of momentum as the mode of operation for pursuing this objective has been well established by the ASTERICS project and the ESCAPE work has benefited a lot from the smooth transition from ASTERICS-DADI to ESCAPE-CEVO. WP4-CEVO partners have interacted with all WP4 ESFRI and RI partners on identifying their needs for common standards for high level data products and archive services to be interoperable in the VO framework. Special emphasis has been placed on new communities, in particular for solar physics (related to EST), and also on interoperability related to gravitational wave data and electromagnetic follow-ups. They have stimulated an increased international effort on radio/mm astronomy data interoperability. The objectives have been refined in the case of CTA and KM3NeT with the identification of synergies on the topic of the use of standards for data provenance. Progress towards the objectives, has already been detailed in two Milestone reports (MS20, MS22), together with the synergy with the IVOA which manages the Virtual Observatory standard. Links to the first objective for connecting the VO to EOSC are well integrated, and WP4 partners have engaged with EOSC and RDA on the topic of FAIR, for example our evaluation of the FAIR Data Maturity Model with respect to astronomy FAIR practices.

- Establish data stewardship practices for adding value to the scientific content of ESFRI data archives

Embracing the new approaches motivated by EOSC, this objective targets specific new capabilities to exploit ICT advances to add value to the content of data archives, with the goal of providing innovative prototype archive services. The work in the first period has focused on the application of machine learning in the context of the ESO archive, with promising initial results for enabling “search by similarity” capabilities for spectral data from ESO instruments. Some preparatory work has been done for the more general objective of identifying best stewardship practices in terms of the human and technical aspects with results to be presented near the end of the project as planned.

2.5 WP5 ESAP

Work package 5 ESFRI Science Analysis Platform (ESAP) focuses on prototyping a functional analysis platform integrating the services developed in the other ESCAPE work packages and tailored to the range of ESFRIs contributing to the project. Specific objectives include:

- Build a prototype science analysis platform that supports data discovery and integration, provides access to software and services, enables user customized processing and

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workflows, interfaces with the underlying distributed, large-scale computing infrastructure, and adds analytics and visualization capabilities tuned to the needs of the ESFRI projects.
- The scale and distributed nature of the data archives generated by current and new ESFRI projects implies that users of the science platform will require access to computing infrastructure and resources that are equally distributed and likely co-located with the data. For the science platform to be effective at these data scales, policies for providing users with the dedicated analysis resources necessary to drive the platform will be required.
- Assessment and adaptation of the science platform to the specific needs of the various ESFRI projects and communities represented by the ESCAPE project.
- Incorporation of the existing and planned EOSC-hub functionalities as well as similar ongoing efforts.
- Development and porting of novel ESFRI tools and workflows to the science platform.

To achieve the objectives the detailed project plan (Deliverable 5.2) was written including the consensus and input of the 17 partner institutes in this work package. During the reporting period two deliverables and two milestones were finalised. All the deliverables and milestones are good indicators of the progress made.

The work in the work package is divided in five different tasks and service components, the tasks and the work that is included are listed below. A detailed description of the tasks and planned partner contribution during the project can be found in Deliverable 5.2.

Task 5.1 - Data aggregation and staging
- Integrate existing IVOA services into the science platform for data discovery.
- Expand and integrate data discovery services to include additional ESFRI data collections Implement basic functionality to estimate and allocate work space for user-specified data sets.
- Provide user tools to estimate and report data availability and latency.
- Demonstrate system capability for a range of ESFRI or related data collections.

Task 5.2 - Software deployment and virtualization
- Integrate ESCAPE-EOSC software and service repository developments through work package into the science platform. Allow users to access and deploy instances of software components to the user workspaces allocated in Task 5.1.
- Expand and integrate availability of software repository metadata to platform users.
- Provide user tools to support the containerization of additional tools and software components for deployment in the Science Platform and subsequent ingest into the ESCAPE-EOSC software registry.
- Demonstrate functionality by building, deploying, and ingesting several ESFRI-specific software.

Task 5.3 - Analysis interface, work flows, and reproducibility
- Setup and operate a functional prototype analysis interface as a proof of concept based upon Jupyter Lab (or equivalent) technologies that integrates functionality from tasks 5.1, 5.2, and 5.4 and supports both interactive and batch analysis jobs.
- Customize the platform to several specific user scenarios incorporating experience from existing ESFRI platform developments.
- Provide user tools to support the construction of user developed workflows and pipelines including metadata to support re-execution and sharing with other users through ingest into the ESCAPE-EOSC software repository deployed in work package 3.
- Develop representative, ESFRI-specific workflows based on current analysis needs.
- Provide user tools for the ingest of derived and value-added science products produced during Science Platform sessions back into the Data Lake deployed in WORK PACKAGE 2.

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- Evaluate performance and responsiveness of prototype Science Platform for several specific ESFRI test cases.
- Development and integration of visualization, machine learning, and advanced analysis tools into the Science Platform.
- Continuous evaluation of the level of reproducibility and achievement of the FAIR principles supported by the platform.

Task 5.4 - Integration with HPC and HTC infrastructures

- Integrate the Science Platform prototype with the Data Lake prototype deployed in WP2.
- Evaluate the behaviour and performance of the prototype for a range of ESFRI use cases.
- Extend the integration of the prototype to include additional ESFRI resources.
- Extend the integration of the prototype to include local user resources.

Task 5.5 - WP5 Management

- Coordination of the technical work in WP5 between the partners, and between tasks.
- Coordination with other technical work packages to ensure that the interfaces between WP5 and the other packages are appropriate and coordinated.
- Responsibility for organizing the milestones and deliverables.
- Brokering the interactions from WP5 to other EU projects, infrastructures, initiatives, and fostering international collaboration around the work in WP5, from interested organisations globally.
- Fostering external cooperation, networking and WP results dissemination.

2.6 WP6 Engagement and Communication (ECO)

WP6, Engagement and Communication (ECO), has several objectives. The goals most relevant to the first year of operation are to establish and execute a dissemination and exploitation plan; to generate standard branding and public engagement materials for ESCAPE (including press communications, interviews, flyers, posters, videos and a booth to be used for events and exhibitions); to create a project website and portal for internal coordination, and internal and external dissemination of ESCAPE results, including the gateway to the catalogue of services; to create brochures for informed communities and public-facing websites for ESCAPE activities; to support attendance at high-level events and meetings where ESCAPE results can be showcased to external stakeholders; to compile Master Classes and mass participation experiment online resources; and to perform internal dissemination of ESCAPE results and the promotion and engagement of the project within the community and beyond. We are currently on track at delivering these objectives. The work package is divided into two tasks. Task 6.1 is focussed on our outward-facing and inward-facing communication. Task 6.2 focuses on using crowdsourced data mining to engage external communities directly with ESCAPE scientific discovery, and is a two-way interaction, as shown in the figure below from the Description of Work.

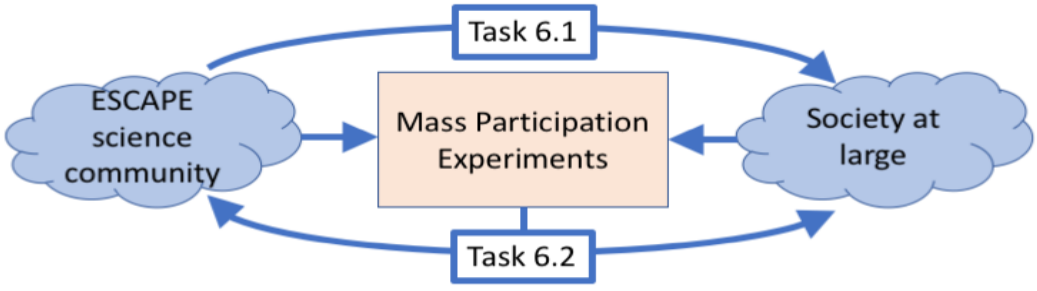

Figure 2: WP6 ECO task organization

2.7 WP7 Ethics requirements

This work package sets out the 'ethics requirements' that the project must comply with. CNRS-LAPP is leading this workpackage and it has an objective of ensuring the compliance with GDPR regulations when personal data shall be collected during the planned project activities.

3. Explanation of the work carried out

This chapter describes the work carried out by each workpackage during the reporting period (1 February 2019 –31 January 2020) in line with the Annex 1 to the Grant Agreement (Description of work). During the first year of the project ten deliverables were submitted and seven milestones were achieved. The full list of deliverables and milestones produced in this period are listed in table 1. These deliverables are yet to be approved by the EC project office. The submitted versions of following deliverables are available on https://mydrive.lapp.in2p3.fr/s/6BjcbYLJ0f5Espq

Table 1: List of deliverables submitted between February 2019- January 2020

Deliverable	Title	WP	Submitted (Y/N)
D1.3	Data Management Plan	**WP1**	**Yes**
D2.1	Implementation plan and design of pilot; R&D questions that will be addressed in the pilot and prototype	**WP2**	**Yes**
D3.1	Detailed project plan for WP3	**WP3**	**Yes**
D3.2	Software and service list and integration plan	**WP3**	**Yes**
D4.1	Detailed project plan for WP4	**WP4**	**Yes**
D5.1	Preliminary report on requirements for ESFRI science analysis use cases	**WP5**	**Yes**
D5.2	Detailed project plan for WP5	**WP5**	**Yes**
D6.1	ESCAPE project website live	**WP6**	**Yes**
D6.2	Dissemination and exploitation plan	**WP6**	**Yes**
D7.1	POPD – Requirement No. 1	**WP7**	**Yes**

List of milestones achieved between 1 February 2019 – 31 January 2020. More details on the first year milestones are available on https://projectescape.eu/deliverables-and-reports

Table 2: List of milestones achieved between February 2019 - January 2020

Milestone	Title	WP	Achieved (Y/N)
MS1	Project Kick-Off meeting	**WP1**	**Yes**
MS2	1st E-GA meeting. Governance entities (e.g. E-EB, E-EAB) and E-MST fully appointed	**WP1**	**Yes**
MS3	1st E-EAB evaluation	**WP1**	**No**
MS7	First WP2 workshop on the initial design and goals of the first pilot data lake, prepare D2.1	**WP2**	**Yes**
MS20	Presentation of progress and results and discussion of	**WP4**	**Yes**

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	priorities at IVOA (1)		
MS21	Progress and priorities at IVOA (2)	**WP4**	**Yes**
MS27	First WP5 workshop on Science Platform design and requirements Means of verification – Workshop summary report	**WP5**	**Yes**
MS28	Review of preliminary report on requirements for ESFRI science analysis use cases by	**WP5**	**Yes**

3.1 WP1 MIND

WP1 MIND started off the project with the project kick off meeting in February 2019. This meeting was organized on 7-8 February 2019 at CNRS-LAPP, Annecy, France and it was a formal milestone of the project. For the first time this meeting brought together around 100 attendees from all the partner institutes and organizations, ESFRI project representatives, other EOSC stakeholder projects as well as e-infrastructures. The ESFRI project representatives discussed the present status of their respective projects and their contribution to the ESCAPE work programme. The meeting was an occasion to present the overall project structure, governance and objectives of the project. All the workpackage leads presented the planned activities as per the description of work in the grant agreement, list of deliverables and milestones as well as reporting period schedule was presented. The executive board, the general assembly members also met for the first time during this meeting. Elena Cuoco, EGO was unanimously selected as the general assembly chair during this event. The project consortium agreement was also finalized and the electronic version was then shared with the project partners.

Figure 3: Group photo - H2020 ESCAPE kick-off meeting, 7-8 February 2019, Annecy, France.

The project launch was widely disseminated through the communication offices of the project partners and ESFRI projects. Simultaneously prefinancing funds were distributed in the first month of the project.

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After the project kick-off, CNRS-LAPP submitted the first deliverable (D7.1) of the project addressing POPD requirement was submitted. This deliverable included list of the project tasks where personal data collection will be required. The report described why such personal data collection is necessary and how this personal data will be collected, processed and stored. While drafting this deliverable we observed that personal data will be collected for event organizational purposes, project website admin rights and to sign up the project members to internal IT tools such as cloud, chat services and project management platform. In all the three cases we observed that project activities are in complete compliance with GDPR.

The first version of H2020-ESCAPE Data Management Plan (DMP) was produced in the first semester. This DMP was a formal deliverable (D1.3) and it is expected to provide a strategy for managing data generated and collected during the H2020 ESCAPE project and optimise access to and re-use of research data. This data management plan was prepared following the guidelines on FAIR Data Management in Horizon 2020. This document provides an overview on what kind of datasets will be collected or generated by each workpackage and how each of the workpackage will make these dataset findable, accessible, interoperable and reusable (FAIR).

The ESCAPE executive board (EEB) is comprised of ESCAPE coordinator, E-MST, workpackage leads and ESCAPE general assembly chair. The executive board is the executing body of the project consortium. Within first year of the project, the E-MST organized six ESCAPE executive board (EEB) meetings through videoconferencing. The EEB meetings allowed the E-MST as well as the workpackage leads to keep track of the project activities, list of deliverables and milestones. Through the EEB meeting, E-MST also shared the EOSC governance updates and feedback from the EOSC events with the workpackage leads. E-MST and EEB members interaction has been very constructive and self-criticising when necessary.

For the deliverable and milestones quality control and submission, E-MST implemented a rather simplified approach during the first year. The workpackage lead and the workpackage members were responsible for the quality control. The workpackage lead checks the final deliverable draft quality and submits it to the E-MST. E-MST then reviews the document and provides comments back to the workpackage lead. If there are no comments from E-MST then the deliverable/milestone is submitted to the EC portal. In addition to the deliverable and milestones, E-MST also provided the workpackage leads with necessary templates for technical reporting as well as an overview of the workpackage specific recruitment. E-MST has also been in touch with the financial divisions of the project partners for financial reporting and estimates to monitor the project spending and recruitments.

E-MST has also finalized the formal appointment of the ESCAPE External Expert Advisory Board (EEAB) members. The EEAB is comprised of following five members.

- Teresa Montaruli, Chair of APPEC - Astroparticle Physics European Coordination committee
- Marek Lewitowicz, Chair of NuPPEC - Nuclear Physics European Collaboration Committee
- Jorgen D'Hondt, Chair of ECFA - European Committee for Future Accelerators
- Colin Vincent, Chair of ASTRONET
- Christophe Arviset, ESA – European Space Agency

The EEAB provides external advice and evaluation of the achievements of the project. The Board brings additional expertise to the project, comments on its progress and results, vision from thematic national research institutes, their encompassed communities as well as from the pan-European space research field so as to orientate the activities towards a full achievement of the goals of ESCAPE with the most inclusive approach.

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E-MST has also been very actively engaging with the European Commission, EOSC stakeholders and the ESFRI projects over the last year. After the kick-off, an initial videoconference with the ESCAPE project officer allowed E-MST to present the project and its objectives in a nutshell as well as understand the expectations of the EC project office from the consortium and important do's and don'ts of an European project. E-MST also represented the ESCAPE project at the Joint CNECT-RTD project meeting and workshop on HORIZON 2020 CONTRIBUTIONS TO BUILDING THE EOSC - 9-10 September 2019 in Brussels. This event gave an opportunity to E-MST to interact with the EC policy officers, EOSC governance board as well as EOSC executive board members and share the expectations of the Astronomy, astroparticle physics and particle physics community from EOSC.

3.2 WP2 DIOS

The first semester of the reporting period (Feb-Jul 2019) focused on setting up the Work Package and defining the architecture and implementation plan. The hiring process was mostly done in this period, while some institutes with lower number of Project Months in WP2 (< 10) are concluding the hiring process in early 2020. In general the Work Package is properly staffed according to the grant agreements and all partners are engaged in the activities. The work package members meet fortnightly in video-conferences and face-to-face at least twice per year, in addition to which we have focused technical meetings.

The architecture of the data lake was agreed early in the process, in terms of functional elements and interactions among them. A high level view of the architecture can be found in Figure 1. The next phase consisted in identifying available solutions that could implement the functionalities needed for the various building blocks and therefore defining a reference implementation. We achieved this through a series of technical meetings where different ESFRI communities involved in ESCAPE presented available solutions from existing (European) projects or developed in the community itself. We identified suitable solutions for all functional elements: Rucio as data lake orchestrator, the File Transfer Service as transport layer, perfSONAR for network monitoring, and XCache for content delivery and caching. The core of the data lake is provided by a heterogeneous set of storage services, such as dCache, EOS, DPM, XRootD, StoRM.

WP2 DIOS partners identified the set of activities needed to build and commission a data lake prototype and the effort that would be required. This information was used to produce the Deliverable 2.1 "Implementation plan and Design of Pilot" in September 2019. The main challenge in this period consisted in carrying on the activities while most of the hiring had not happened yet. The partners however contributed substantially to the process through unfunded effort.

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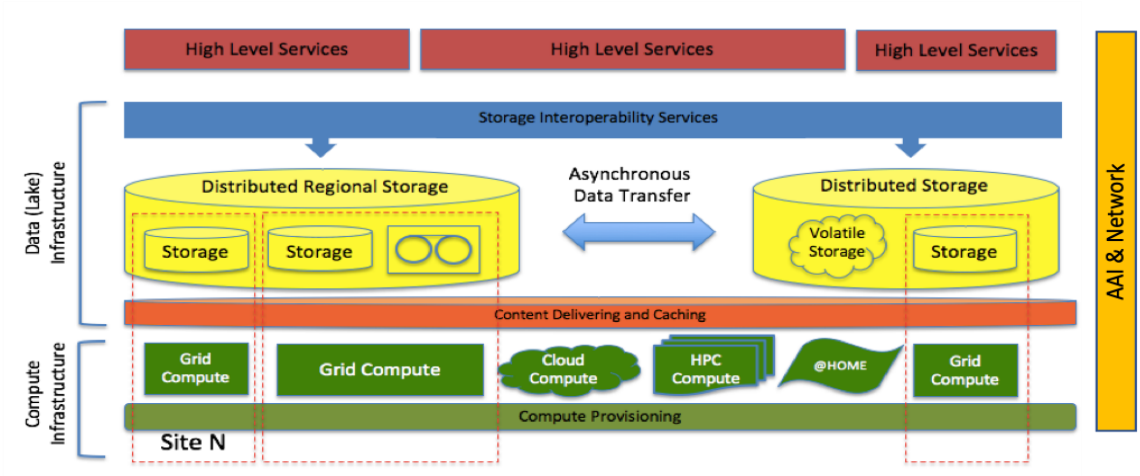

Figure 4 building blocks of the data lake architecture

In the second part of the year WP2 DIOS started the implementation of the data lake pilot. The storage systems at the data centres of most WP2 partners were configured to support the ESCAPE community. A central ESCAPE instance of Rucio was deployed as data lake orchestrator using Kubernetes as infrastructure layer. It was configured to include all the aforementioned storage endpoints. A production-quality file transfer service has been configured to transport data from each pair of endpoints through different protocols, such as gridFTP, HTTP and xrootd. At the time of writing this report, nine storage endpoints are part of the pilot data lake and all storage implementations mentioned above are present. We note that the pilot to be assessed in Month 24 of the project should contain at least three endpoints, therefore we are well on schedule. We have also contacted and included in the discussion some organisations which are not part of ESCAPE but which are strategic for some of the ESFRIs in ESCAPE. One such example is AARNET, which is strategically important for SKA in that it can mimic an SKA data source location. AARNET is in the process of providing an endpoint for the data lake.

The content delivery layer is being built up. In the end of 2019 several functionality and stress tests were carried on for the reference implementation with satisfactory results. An instance of the IAM service was deployed for ESCAPE and is currently used to manage the ESCAPE Virtual Organisation. It can provide both token-based and X509-based authentication and authorization in line with the plan which foresees the coexistence of the two for the timescales of ESCAPE. Network monitoring was also put in place by through a dedicated view and set of tests in the perfSONAR infrastructure, also in use by WLCG. The evaluation of storage Quality of Service solutions is underway.

All partners are engaged in WP2 activities. CERN is providing the central instance of Rucio and coordinating the deployment of the data lake, prototyping the content delivery layer, integrating token-based authentication in the data lake and providing network monitoring. DESY is driving the storage Quality of Service activity and prototyping in dCache most of the innovative aspects in ESCAPE, such as token-based authentication and event driven data processing. FAIR/GSI and RUG are working on a streamlined data lake implementation, to demonstrate how different science communities retain flexibility to customise the reference implementation. INFN, leading the effort of Authentication, Authorization and Identity management, is offering the services for this purpose and driving the process to migrate to token-based authentication and authorization. SKAO, CNRS-LAPP and ASTRON worked on the integration of the SKA and CTA specific processing workflows and data management policies with the data lake. Almost all the partners mentioned above provide at least one storage endpoint in the data lake. The same is true for the other partners such as IN2P3-CC, IFAE, Nikhef and SURFsara.

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3.3 WP3 OSSR

The first six months of the project have been used as a ramp-up phase of work-package organisation and for the hiring processes. The resources available to the partners have been collected and are monitored on a half-yearly basis. The main contact persons of all 19 partners are identified and actively involved in the project progress.

Constrains and interfaces have been defined between the work packages of ESCAPE and within WP3, the main responsible persons acting as interfaces between OSSR and the ESF/RI's have been identified as well. All partners are well linked to the working group, following the activities and meetings as well as contributing their work.

Two main challenges arose in the beginning of the project: The high number of partners and diversity in software development and deployment techniques in the different communities linked in ESCAPE made it necessary to start the collaboration with a collection of "where we stand". This has been solved by a partner survey, the first all-hands meeting in July 2019 and follow up activities in the respective focus groups. Due to the generally good economic situation in the EU, several hiring processes have been delayed, however, without significant impact on the project.

One of the major tasks in the first year was the definition of the project plan for WP3 which was delivered as D3.1 (M09). It contains the plan to implement the goals and objectives of WP3. The next deliverables are under preparation: the list of software and services to become part of the ESCAPE repository (D3.2, due M12) – its review being milestone M14 (due M15), the conceptual design report on the OSSR (D 3.3, due M18) and the establishment of the innovation competence group via a workshop in July (D3.4, due M18). In addition, the ESCAPE school to teach young scientists software development in a collaborative and open source environment is prepared for June 2020.

In addition to the work organisation as mentioned above, in task 3.1, a helpdesk for all partners as well as the link within ESCAPE and towards the EOSC Architecture Working Group have been established.

In task 3.2, the development, benchmarking and deployment of software within and across partners has started as well as gathering of common practices and know-how towards the definition of best practices to be shared with the community. A first round of software to become part of the repository is collected, a template for software gathering set up, and the partners started to prepare the software for the latter purpose. Contact with the HSF has been established discussing the options to add HSF software to the repository.

In task 3.3, coordinative work for common data formats and software tools between the partners and the ESF/RIs they represent has started. Development and production of CORSIKA – an air shower simulation program - turnkey containers for various use cases and functional development of CORSIKA for specific purposes is pursued. It is explored to use the DIRAC interware for large scale simulation productions.

In task 3.4, machine learning approaches to simulation and experiment data have been adapted and benchmarked; definition of data formats and different deep-learning approaches have been pursued as well as the exchange of experience and harmonisation of approaches for innovative workflows. Data processing workflows between different partners have been gathered and the establishment of use cases for multi-messenger analysis workflows connecting several ESFRIs has started.

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In task 3.5, the partner feedback for the repository has been gathered. Based on this, the preliminary design of the repository and the definition of technical solutions for its implementation has been developed and a first prototype set up for internal use.

3.4 WP4 CEVO

CEVO brings together partners with expertise in the VO framework, with partners who are connected to the ESFRI projects and other research infrastructures. VO expertise is provided by: CNRS-ObAS, INAF, INTA, UEDIN, UHEI and ObsParis. ObsParis brings a special link between VO and the CTA. The ESFRI and other research infrastructures are two projects from the ESFRI Roadmap: the European Solar Telescope (EST), and the cubic-kilometre-sized Neutrino Telescope (KM3NeT) ; and the ESFRI landmark projects: Cherenkov Telescope Array (CTA), Extremely Large Telescope (ELT) and the Square Kilometre Array (SKA). The pan-European International Organization European Southern Observatory (ESO) brings other world-class established astronomical observatories (e.g. ALMA, the La Silla Paranal observatories). Additionally the research infrastructures European Gravitational-Wave Observatory (EGO-Virgo) and the Joint Institute for VLBI ERIC (JIVE) are also participating directly in the work package.

The first period of the project has involved setting up the work package. The first six months was an administrative start-up of the activities at all of the partners, and also involved definition of the leaders of the three tasks. The organisation has been done via many specific meetings and videocons with the relevant groupings of partners on the detailed topics of the tasks. A meeting of main contacts from all the partners was held in September 2019. A major face-to-face meeting of the whole work package was held 4-6 February 2020 (40 participants), the WP Technology Forum 1 , which collected many of the results of the first year of the project , and served to plan the work to be done in 2020 as well as preparation for the next deliverables, milestones and events.

February 2019 – April 2019 was the overlapping transition period from ASTERICS to ESCAPE. The main transition events were the “Technology Forum 5” of ASTERICS-DADI (Strasbourg, 26-28 February 2019) and the New Era of Multi-Messenger Astrophysics conference (Groningen, 25-29 March 2019). We took advantage of this overlap to hold specific side-meetings on “EST and the VO” and on “Radio Astronomy and VO” which also included early interaction with ESCAPE WP5.

- Detailed WP4 Project Plan

The Detailed WP4 Project Plan (D4.1) was delivered to the project on 12 July 2019. All partners contributed to the development of the Project Plan. D4.1 serves as the work plan at the beginning of the project, and will be adapted throughout the project based on the progress and results. The plan is designed to serve as a guide to the partners for the organisation and monitoring of the work.
The project plan is structured into four tasks: “Integration of astronomy VO data and services into the EOSC”, “Implementation of FAIR principles for ESFRI data through the Virtual Observatory”, “Adding value to trusted content in astronomy archives” and a “WP4 management” task. High level descriptions of all of the tasks and sub-tasks, cross-referenced with the milestones and deliverables, are provided.

For the major task of “Implementation of FAIR principles for ESFRI data through the Virtual Observatory”, the activities related to each domain area of “Solar Physics”, “Radio and Millimeter Astronomy”, “High Energy Astrophysics”, UV/Optical/IR Astronomy, “Neutrino Astrophysics” and “Gravitational Wave Astrophysics”, are linked to the relevant ESFRI and RIs and the initial set of events associated with this main task is outlined. The management task covers the coordination of

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the various activities in WP4, as well as overall coordination with the other work packages in ESCAPE. The roles of each of the partners, the main contacts, and a calendar of events has been established. The planned person-month effort has been established for each partner with the expected contribution of each partner to the various tasks.

- Connecting to EOSC

VO Resource mapping against the EUDAT B2FIND metadata has been done as the first step of including the Virtual Observatory Registry in EOSC. This mapping of VO resources to the DataCite-based EUDAT catalogue service has been done and has been validated as working. It can be accessed through the EUDAT B2FIND service itself. This first step has identified various challenges of mapping the metadata – while B2FIND can list VO services, further development would be neccessary in order to represent the VO interfaces on services, i.e. to convey that a particular service can be queried as a TAP services. This defines a next step for interaction with EUDAT. Contact points within EOSC have been identified for catalogue integration and the service portfolio. The preliminary identification has been made of the VO services and tools to be used in containerisation tests (e.g. TOPCAT, as presented at WP4 Technology Forum). Also the first steps have been taken in an investigation of how to integrate a service into EOSC, showing that at present the available EOSC components can be used as a kind of look-up system that then directs you to the individual service web page and portals. We also found that the response time for requests to the EOSC help systems would need to be improved, and that more 'sandbox' test environments would be beneficial.

We have contributed to specific EOSC events to represent the ESCAPE project and to interact with EOSC contact points. The events in the first year have included the EOSC-hub Week Prague, 10-12 April 2019, EOSC Symposium Budapest 26-28 Nov 2019, as well as RDA plenaries with co-located EOSC events.

- Definition and adoption of common open IVOA standards

The work on the definition and adoption of common open IVOA standards based on ESFRI requirements has progressed via specific meetings, and concerns the preparation and participation in the International Virtual Observatory Alliance (IVOA) interoperability meetings which are milestones. In the first year of the project the initial requirements of the ESFRIs for VO standards and tools have been assessed and included in the work plan.

Specific meetings with the ESFRI and RI partners have included: The "EST and VO" meeting (Strasbourg, 26 February 2019), the "Radio Astronomy and VO" meeting (Strasbourg, 28 February 2019), CNRS-ObAS visit to ROB (Brussels, 11-12 March 2019), "KM3NeT and VO" meeting (Strasbourg, 5 July 2019), the "CTA and KM3NeT Provenance Meeting" (Strasbourg, 6 November 2019), UHEI visit to ECAP, Erlangen (25-26 July, 2019) on the topic of VO publishing for neutrino data, UHEI visit to KIS Freiburg (12 November, 2019) on the topic of publishing solar data via EPN-TAP, UHEI visit to ASTRON (Dwingeloo, 6-10 January, 2020) on the topic of registering VO services.

A large amount of work has been done to prepare and participate in the IVOA interoperability meetings. These working meetings are major Milestones for WP4, Milestone MS20 "Progress and Priorities at IVOA (1)" for the Paris (12-17 May 2019) meeting and Milestone MS22 "Progress and Priorities at IVOA (2)" for the Groningen (9-11 October 2019) meeting. Detailed reports of these milestones have been prepared (in addition to the short milestone text provided into the EC portal). These milestone reports describe the progress of the work package activities that have been presented at the IVOA meeting, and the discussions held at the IVOA meeting on the priorities for the development of standards relevant to the ESFRI projects and other research infrastructures

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participating in CEVO. The participation of ESCAPE partners in IVOA meetings is tracked, as is the wider European contributions to IVOA.

The Milestone reports show that there was strong participation by WP4 partners in the IVOA meetings (30 contributions in May 2019, 22 contributions in October 2019) with representation of all of the VO-expert partners, and representation of ESFRI and RI partners: ROB for EST, ESO, SKAO, ASTRON for SKA/LOFAR, JIVE, CTAO, ObsPARIS for CTA, plus input prepared for ALMA, EGO-Virgo and KM3NeT. The WP4 partners also facilitated the participation of a representative from EUDAT (C. Martens, DKRZ) to enable liaison with EOSC at the IVOA level. This also represents a strong interaction between tasks 4.1 and 4.2.

The top level result of this significant participation in IVOA is that the priorities of the ESFRIs and RIs are being taken into account in the definition of common interoperability standards at the international level. This is in particular the case for the new domain of solar physics, associated with EST. It brought in the aspects of ground based solar physics to IVOA, and it enabled significant progress to be made in terms of identifying the elements of the VO that are relevant for solar physics and for this activity to be integrated into the work of the IVOA Solar System Interest Group.

Another area in which ESCAPE participation has made a significant impact at IVOA is the domain of radio and millimetre astronomy. The partners contributed to the organisation of a “Focus Session on Radio Astronomy and VO” at the Groningen meeting, and this enabled the ESCAPE partner radio/mm astronomy priorities to be addressed in the international context of the IVOA. The session was led by the IVOA Committee for Science and involved other international radio astronomy infrastructures (VLA, ALMA, ASKAP, MWA) and data centres with interests in radio astronomy (CDS, CADC, CASDA). This session explored the global top-level needs for interoperability of radio astronomy data and services, and the significant challenges ahead for very large data volumes. Following these interactions, a Radio Astronomy Interest Group has been proposed at IVOA with decision to be made in 2020.

An example of WP4 results that will be relevant to WP5 is the technical development towards enabling the access to VO data resources via science analysis platforms. CNRS-ObAS work on improvements to Aladin Lite and associated widgets have led to a prototype WebGL version of Aladin Lite (see image) that enables use of multiple sky projections and will enable easier integration of complex visualisation layers.

Another early result is that ASTRON has made a VO service findable through the IVOA registry, increasing the amount of available radio data in the VO by the LOFAR and WSRT surveys which are or will shortly findable through this service. Also the first steps have been taken to have a proof of concept of an interface that can be used to simultaneously query both the VO and other archives of ASTRON data with the goal of evolving towards the data access layer of the WP5 platform (ESAP).

- Interactions with RDA and other bodies on FAIR principles

All of the CEVO tasks have relevance at the international level in the Research Data Alliance (RDA). In the first year of the project the work in Tasks 4.1 and 4.2 has included interaction at RDA meeting, in particular the RDA 14th Plenary (and its co-located events) Helsinki 23-25 October 2019 where there were a number of EOSC-RDA events. The most relevant RDA activities have been identified to be: the Global Open Research Commons Interest Group (because it concerns EOSC and other similar initiatives), the Data Repository Audit and Certification (in particular the Core trust Seal certification), and also the FAIR Data Maturity Model Working Group.

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One of the main outcomes of the CEVO partner interactions with RDA is our evaluation of the core criteria for FAIR data, done in November 2019 – February 2020, that has been provided to the RDA FAIR Data Maturity Model Working Group. The results of the tests show that astronomy data providers' goals are focused more on Re-use and Interoperability, and that 'open data', the usual model of astronomy, should be better taken into account without imposing additional requirements such as providing a usage licence. We have identified several other issues with the definitions of 'priority criteria' in order to take into account the real practices in astronomy, and have fed these back to the RDA working group. Further detailed tests are ongoing, and the topic is also being written into an IVOA note document which will be a product of ESCAPE CEVO.
Adding value to the scientific content of ESFRI data archives

- Adding value to the scientific content of ESFRI data archives

The work on the task for adding value to the scientific content of ESFRI data archives has been very active in the first year. A specific recruitment was made at ESO, and the HITS partner (interface with WP3) has organised to use the resources in the first part of the project along with concurrent contributed effort. Three meetings between the CDS, ESO and HITS lead to the concept of using machine learning techniques to prototype a search mechanism for "similar" data. "Similarity Search" techniques have been developed using dimensionality reduction so that a projected space (in 2 or 8 dimensions as tested so far) can represent a very large data set.. The ESO HARPS spectra were used as the first test data set, and the results show that even a 2-dimensional projected space is useful for representing the full set of HARPS spectra, and that this lends itself to interactive visualisation (and on-the-fly learning) interfaces. 8-dimensional projected spaces provide more detail, but greater challenges for interactive exploration. Encouraged by the first results, the more diverse spectra collection from the UVES instrument will be tested, and the concepts for interfaces with the archives services will be developed further. Plans for adding value to catalogue and cube data have been made for later in the project.

- Challenges faced in the first year of the project

The ESFRI and RI partners are diverse and started the project with different level of familiarity with VO framework. To address this we have used specific targeted meetings to combine VO expertise and ESFRI/RI expertise in discussions at the right level, but of course it took time and effort for this customised approach.

Planning for the use of resources has involved an initial estimate of each partner's contribution over the duration of the project. This has been very important in particular as many partners have resources of less than 15 person months in the work package, and many of the partners have effort that is spread across multiple work packages with individual personnel contributing to multiple work packages. We also note that there are contributed unfunded efforts in a number of the partners.

Some tasks are weighted toward the beginning of the project for various reasons, so it has been necessary to take this into account. The timescale for the use of the ESCAPE resources at the HITS WP3 partner is the first 18 months of the project, so many machine learning aspects were worked on intensly in the first part of the project (while other partners were still ramping-up).

Several partners have reported difficulty with the travel budget, which is not sufficient for the activities, in particular for representation of ESCAPE at IVOA interoperability meetings.

Hiring at JIVE required a change of plans due to visa issues with a selected candidate. Dutch immigration followed the advice of the Dutch unemployment service to deny a work visa for our (non-European) candidate, based on the arguments that not enough effort was spent on disseminating the

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job advertisement Europe-wide nor on considering the qualities of European candidates sufficiently (seven out of eleven respondents were European, two out of the three interviewees were European). The final decision reached JIVE by the end of October 2019, after which it was decided to fund the WP4 tasks out of own personnel. This delays the start of work considerably.

The work at the KIS partner was impacted by the departure of one person who was allocated to work on this work package, hence the work at KIS has been subject to a delayed start and has required a minor re-organisation, in particular C. Schaffer is now fully funded for 12 PM by ESCAPE. Recent work shows that this on-track, for example a working installation of the VO publishing “DaCHS” has been implemented, as well as a prototype of a VO TAP service.

We have requested a delay for the deliverable report for the first “Science with interoperable data school”, D4.3 (originally planned for before Month 16). The event itself has been delayed due to availability of the venue, and while the event will occur before the deliverable date, the report will take a number of weeks to prepare after the event, hence the requested delay of the deliverable to Month 18 (July 2020).

3.5 WP5 ESAP

The first four months were focused on the organisation of the work package, hiring and finding the main contact persons at partner institutes. To stay up-to-date with developments and to share information we decided to organize monthly teleconferences and biweekly tech meetings. More information about these meetings are available on the WP5 Indico page: https://indico.in2p3.fr/category/846/

The first ESFRI Use Case Requirements workshop was organised in April in order to identify the requirements for the ESFRI Science Analysis Platform from ESCAPE ESFRI partners (Milestone 5.1). During the workshop, several sessions were held to discuss identified ESAP components and the priorities of implementing each of the services. The results of this workshop were reviewed (Milestone 5.2) and reported in Deliverable 5.1 a Preliminary report on requirements for ESFRI science analysis use cases.

From August to October, all partners were engaged to contribute to the detailed project plan. With the identified ESFRI Science Analysis Platform (ESAP) components and the priorities of implementing each of the services, the detailed project plan was written (Deliverable 5.2). This plan now serves as the work plan and will be updated throughout the project.

The ESAP architectural design was also made during this period as part of the detailed project plan. We also identified the ESAP Minimum Viable Product (MVP) core team, which leads the development of one or more service categories. These service categories can be mapped onto work package tasks as described in the Detailed Project Plan (Deliverable 5.2).

- Summary of the tasks and the activities

All partners are engaged in WP5 activities. Some partners contributed a bit less than the others due to job vacancies that still need to be filled in. In general, several partners (*e.g*. CSIC, SKAO) have contributed use cases and user stories in order to find the commonality between ESFRI requirements on Science Platform functionalities.

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Partners such as UEDIN, JIVE have been working on setting up Jupyter Notebooks, and have been actively involved in both work package 4 and work package 5, such that the connections between Science Analysis Platform and VO tools and libraries are well understood.

Nikhef, CTAO, SKAO and INAF have worked on exploration of the integration of various common HTC/HPC tools and services, where Nikhef particularly focused on the authentication and authorization components of those tools.

All partners participated in the monthly teleconference and biweekly tech meeting regularly and most of the partners contributed to the writing of deliverables.
Each of the WP5 MVP (Minimum Viable Product) core team partners are leading the development of one or more service categories:

- ASTRON is leading the development of the ESAP User Interface (UI) and Application Programming Interface (API) Gateway.
- SKA and CTA lead the aspects of data lake and workload management integration.
- Nikhef leads on the federated-Authentication and Authorization Infrastructure (AAI) aspects.
- UEDIN leads the IVOA integration and interactive data processing services.
- INAF is leading the development of batch processing.

All partners are engaged to participate in the development of these service categories. Since the architectural design of ESAP has taken into account the multi-institutional nature of the work package, it allows services to be developed separately and be integrated through API calls. Therefore, the design makes the collaboration among work package partners much easier.

- Summary of milestones and deliverables

There were two milestones (M) for work package 5 to complete in period 1:

- First ESFRI Use Case Requirements workshop (M5.1, month 4)
- Review of preliminary report on requirements for ESFRI science analysis use cases by WP5 task leader and ESFRI representatives (M5.2, month 5).

Both milestones were reached.

Work package 5 had two deliverables (D) in period 1:

- Preliminary report on requirements for ESFRI science analysis use cases (D5.1, month 6)
- Detailed project plan for WP5 (D5.2, month 9)

Both deliverables were completed and submitted. 3.5.5 SWOT Analysis

3.6 WP6 ECO

• Task 6.1 Public engagement and communication

A dedicated ESCAPE branding was designed to ensure immediate impact. The main logo was designed to be included in all ESCAPE templates for presentations, documents, the project website, social media platforms, videos and flyers. Another 5 logos were designed for each one of ESCAPE services, with some design updates during the first year. The “D6.1 - ESCAPE PROJECT WEBSITE LIVE” has more detailed info about the ESCAPE branding rationale.

Designed and launched the ESCAPE website (https://projectescape.eu), an integrated and versatile platform aimed at animating its community of users. It is a dynamic platform that will evolve during the project timeframe to include additional features to serve the project’s community and scope.

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The "D6.1 - ESCAPE PROJECT WEBSITE LIVE" was pulled out by M8 (September 2019) with more detailed info about the website development and structure. By end of Y1, ESCAPE website registered 1.883 users, along with 10.924 page views.

With the assistance of WP3 members (namely form Kay Graf) and WP1, WP6 defined internal communication platforms to make it easy for all ESCAPE consortium members to have a virtual area where they can easily access all project data and to interact with each other, in the most efficient way:

- Chat Server: https://chat.escape2020.de/home
- Document Repository: https://cloud.escape2020.de/
- Project Management: https://project.escape2020.de/
- Event Organiser Tool: https://indico.in2p3.fr/

Various communication materials have been prepared for the project. They have been used to raise awareness and understanding of the ESCAPE offer and ESFRI facilities such as interviews from different stakeholders, presentation video, flyers, webinars, posters, rollup banners and other relevant ones. All communication materials are available in project's internal repository for the project's consortium benefit, and all public material are also linked to the public website, under the Communication Kit. The material produced during year 1 are:

- 2 posters:
  - Poster 1 https://projectescape.eu/sites/default/files/ESCAPE_Poster_Feb_2020.pdf
  - Poster 2 https://projectescape.eu/sites/default/files/POSTER%20P2-1_Molinaro.pdf
- 1 flyer: https://projectescape.eu/sites/default/files/ESCAPE_Flyer_21x21_Feb_2020.pdf
- 1 rollup banner: https://projectescape.eu/sites/default/files/Rollup_January2019_2_v2.3_0.pdf
- 3 video interviews:
  - Video 1: https://www.youtube.com/watch?v=tEpVIjVY-T0
  - Video 2: https://www.youtube.com/watch?v=zxhpFWnW1JU
  - VIdeo 3: https://www.youtube.com/watch?v=2b3jjg8ArZU
- 1 position paper: https://www.projectescape.eu/sites/default/files/Escape_position_statement_web.pdf
- 1 press release: https://www.projectescape.eu/communication-kit/eu-particle-physics-astronomy-commit-research-data-revolution-making-european-open
- 3 giveaways: pens, notepads and bags with ESCAPE branding
- 2 banners and programs:
  - https://indico.in2p3.fr/event/20306/
  - https://indico.in2p3.fr/event/20203/

Submitted by M12 the "ESCAPE D6.2 - Dissemination and Exploitation Plan", a document describing how ESCAPE will raise awareness, engage stakeholders, promote the project and its related results, achievements and knowledge generated, while also setting a solid basis for its future exploitation. The document defines quantitative KPIs, useful to monitor the dissemination impact.

Regarding social media, 3 channels were created to build ESCAPE community and draw attention to the project and its outcomes, achievements and updates:

- Twitter: https://twitter.com/ESCAPE_EU | 281 followers & 256 twees
- LinkedIn: https://www.linkedin.com/company/projectescape | 88 followers
- Youtube: https://www.youtube.com/channel/UC05braEQdP2rCSUamHm9I_Q/featured | 104 views | 2 subscribers

In order to keep followers informed, to reinforce their commitment or to draw attention to an event in real time, live tweets were organized on several occasions:

- Building Open Science in Europe: The road ahead for the EOSC community, Tallinn - June 2019

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- RDA Plenary Meeting, Helsinki - October 2019,
- EOSC Symposium, Budapest - November 2020,
- WP4 Technology Forum, Strasbourg

The first issue of ESCAPE newsletter was started being prepared by M12 (January 2020), to be launched by M13 (February 2020). In order to populate the number of newsletter receivers, during Y1 the WP6 informed potential subscribers through events, face-to-face meetings, consortium network and social media that they could subscribe to this service. Plus, it was set up a way to sign up for newsletters through the website. This is done on the ESCAPE website, either when creating a user-account on the website or subscribing to the newsletters in a dedicated area available on the homepage.

A dedicated page has been set up (https://docs.google.com/spreadsheets/d/1gRjH7Ca_QVNdHv1HQHP2_WSZUXA2oNTh_B2tGBVdX8w/edit#gid=145131489) to collect all the relevant details to track and monitor ESCAPE event participation. In addition, the ESCAPE event participation is highlighted on the web platform's Events section, to inform beforehand the audience that they can meet ESCAPE partners there: https://projectescape.eu/events?tid=2 Full list of events were listed in deliverable D6.2.

Some synergies were established in the domain of open data management and data systems of the ESFRI projects, exploring standards, prototyping and deploying advanced open data services, towards the development of a consistent European research infrastructure ecosystem. More details on these synergies were reported in deliverable D6.2.

• Task 6.2 Open Education and Citizen Science programme

Galaxy Zoo: Clump Scout is a new citizen science project that will help discover how galaxies form and evolve.

One of the main goals for modern observational cosmology is to discover and understand how galaxies and their constituent substructures have assembled and evolved throughout cosmic history. The diverse observed morphologies of individual galaxies are not only indicative of their current composition, but also encode a detailed record of their assembly histories, their past and ongoing star formation, and their interaction with local environments.

Galaxies grow by forming stars. Today, the Hubble Space Telescope can detect distinct star-forming structures inside the galaxies that populated the Universe when it was less than a quarter of its current age. These early galaxies look very different to their modern-day counterparts. Their disks are thick, turbulent and violent environments, where hundreds of new stars are born every year. Many also exhibit giant regions of enhanced star formation that appear as bright clumps in telescope images. In contrast, today's star forming galaxies are typically much more placid. Their disks are thin and well-ordered and clumpy star formation is much less common.

These profound differences raise obvious questions. Which physical mechanisms drove the observed evolution in star formation activity? Why are giant star forming clumps so much more common in the early Universe?

To understand why clumpy galaxies became so rare, we need to find and investigate as many examples as possible. One potential approach involves training modern deep learning algorithms that

use deep learning to identify galaxies with clumps. However, appropriately labelled training data for clump detection is scarce and laborious to generate. Moreover, automatic algorithms struggle to operate effectively if their limited training datasets underrepresent the diversity of the data being analysed. In contrast, human beings working in collaboration can extrapolate successfully from a handful of examples.

To benefit from this impressive human capability, we used the Zooniverse platform to develop a new citizen science project called Galaxy *Zoo: Clump Scout*. The project invites the general public to examine images of galaxies obtained by the Sloan Digital Sky Survey (SDSS) and annotate all the clumps they can see. By participating in *Galaxy Zoo: Clump Scout*, volunteer clicks will identify the locations of clumps within thousands of galaxies in the nearby Universe. The project uses a novel Bayesian aggregation algorithm that dynamically derives a consensus for the clump locations based on the annotations provided by multiple volunteers for the same image. The algorithm also estimates the reliability of the dynamic consensus, which helps to ensure completeness while avoiding spurious clump detections. Galaxy *Zoo: Clump Scout* represents one of the first large-scale studies of clumps in local galaxies.

In the future, new space telescopes like *Euclid* will image more than a billion galaxies. Using citizen science to manually check so many galaxies for clumps would take many years, even for the most dedicated *Clump Scout* volunteers. The speed of computer algorithms will be required to process such large volumes of data and we have adapted the *TensorFlow* Faster-RCNN implementation to detect clumps using 5-channel imaging SDSS data with promising results. However, there will always be galaxy images that confuse the computer algorithms and we'll need the help of the *Clump Scout* volunteers to step in when deep learning fails. Even more importantly, human beings inspecting images are much better at spotting any unusual or unexpected phenomena that single-minded algorithms would just ignore. Indeed, the history of citizen science is full of examples when keen-eyed volunteers make amazing, serendipitous discoveries. Projects like *Clump Scout* will help to maintain this tradition in the future.

You can join in the search for clumpy galaxies at *Galaxy Zoo: Clump Scout*.

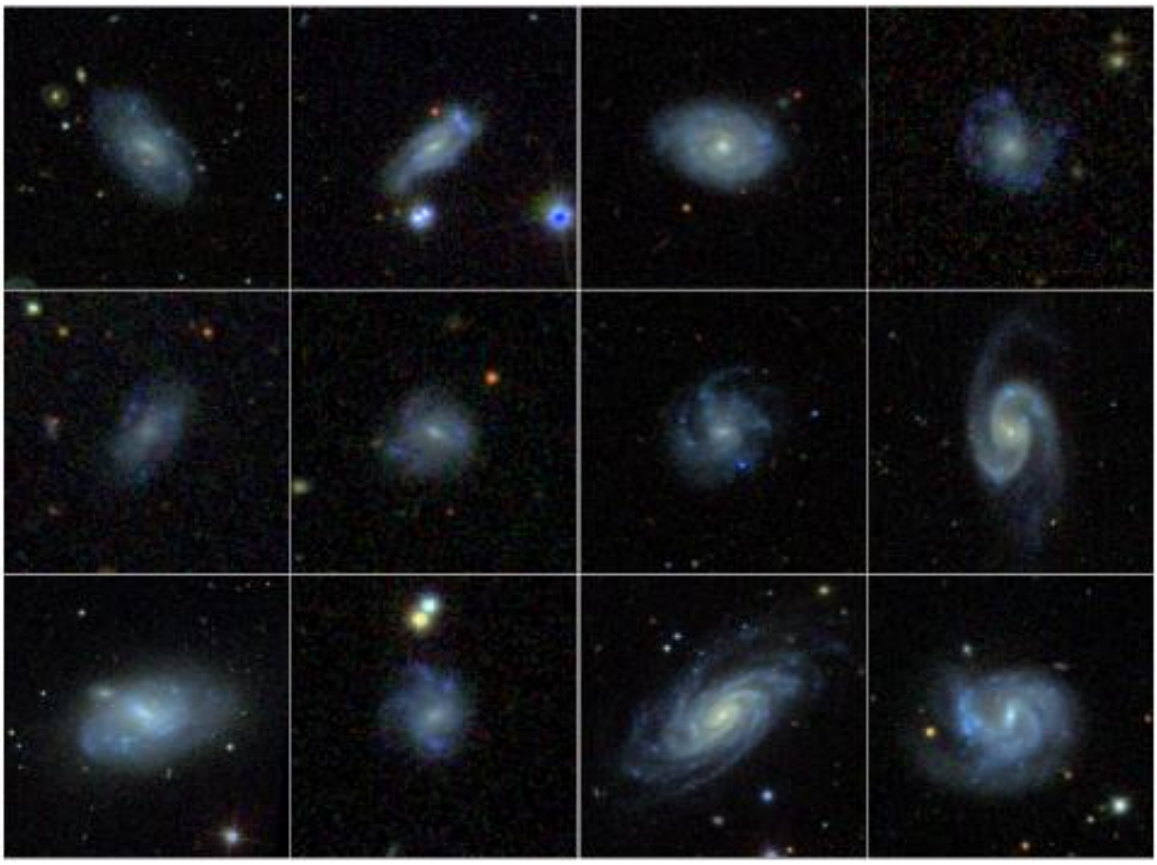

Figure 5: Some examples of clumpy galaxies that will appear in Galaxy Zoo: Clump Scout. In these images, clumps look like small, blue spots on the galaxies. Some of the clumps in these images are bright and obvious, while others take a bit more care to spot. All photos were taken by the Sloan Digital Sky Survey.

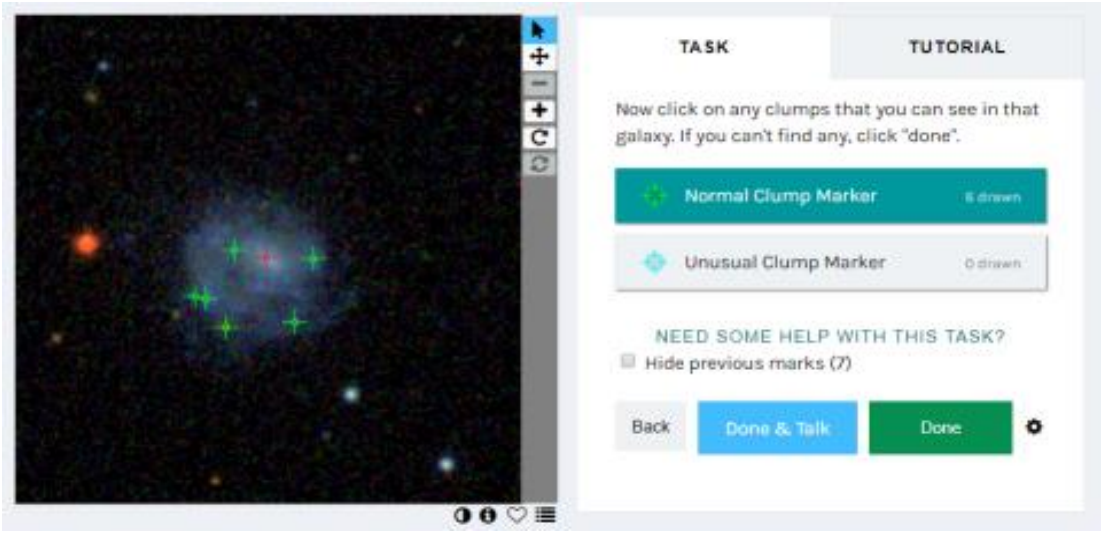

Figure 6 A classification from Galaxy Zoo: Clump Scout. Here, a red icon marks the central bulge of the galaxy, while six green icons mark clumps.

The *Low Frequency Array* (LOFAR) is a large interferometric array of radio telescopes located primarily in the Netherlands, but with outlying antennae dispersed across Europe. LOFAR is also a recognised science and technology pathfinder facility for the next-generation radio telescope, the Square Kilometre Array (SKA).

Radio Galaxy Zoo: LOFAR (https://www.zooniverse.org/projects/chrismrp/radio-galaxy-zoo-lofar) is a new citizen science project led by ASTRON in the Netherlands with substantial ESCAPE-funded support provided by the Zooniverse platform and the Open University (OU) The project invites volunteers to classify radio images extracted from the first data release of the *LOFAR Two-metre Sky Survey* (LoTSS) which covers 424 square degrees in the region of the HETDEX Spring Field. In this release, 325,694 individual radio sources were detected with a signal five times greater than a typical background noise fluctuation.

Classification entails attribution of distinct regions of radio emission to a single origin and (where possible) identifying an optical counterpart for the radio emission's source. By Zooniverse standards this is a very complicated analysis task, which requires consideration of multiple images, representing radio and optical data. Moreover, the degree of scientific comprehension that volunteers require to successfully provide the required classifications is more than typical Zooniverse projects, which often rely on somewhat mechanical "microtasks" that can be performed without complete understanding.

To render such complex classifications tractable for citizen scientists, the OU and Zooniverse teams have developed an advanced volunteer training and feedback system. The project uses a tutorial video paired with a dedicated training workflow that allows volunteers to mimic the classification process as demonstrated by one of the LOFAR project scientists. The training workflow presents subjects in the same order as they appear in the video (unlike the normal random ordering employed by the Zooniverse platform) and volunteers receive real-time feedback in response to the annotations they provide. This is the most advanced training infrastructure that has been deployed using the Zooniverse project builder platform and the upgrades that have been developed by the OU and Zooniverse with ESCAPE support will be available for future CS projects to leverage. It has been shown that volunteers' confidence is a critical factor in citizen science projects, which improves classification accuracy and volunteer retention.

Radio Galaxy Zoo: LOFAR is currently undergoing "beta" review by a cohort of experienced Zooniverse volunteers and will launch in mid-February 2020.

3.7 WP7 Ethics requirements

This work package sets out the 'ethics requirements' that the project must comply with. CNRS-LAPP is leading this workpackage. Deliverable D7.1 POPD requirement was submitted under this workpackage. As per the H2020-ESCAPE grant agreement POPD requirement 1 concerns the ethics issues on personal data collection, processing and storage. In this deliverable, we first enlisted the tasks where personal data collection will be required within H2020-ESCAPE. We then described why such personal data collection is necessary and how this personal data will be collected, processed and stored.

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4. Future plans (February 2020 – August 2020)

This chapter describes activities planned for the upcoming six months leading to the mid-term review in September 2020. Based upon the experience in the first year of the project, a SWOT analysis has been performed to give more insights on the project progress.

- ## WP1 MIND

E-MST future activities include the organization of the first ESCAPE progress meeting. This meeting will be organized in Brussels on 26-27 February 2020 and it will bring together over 100 attendees from ESCAPE consortium members, EEAB members, representatives from other EOSC stakeholder projects and EC policy officers for the first time since the kick-off event. Keeping in mind that the project plans from all the workpackages were submitted over the last year, the first day of the meeting will be dedicated to discuss cross-workpackage interfaces. The second day of the meeting will be dedicated to discuss how the researchers' engagement in the implementation of EOSC. This meeting will also have a reserved session for the second ESCAPE general assembly with EEAB members. During this second ESCAPE general assembly, the project progress over the last year along with the financial forecast will be discussed.

Dark Matter is one of the subjects originally considered in the ESCAPE work program as a Test Science Project (TSP) case in the remit of Open Science to Open Data & Reproducible Science. E-MST is now encouraging the discussions within the ESCAPE ESFRI projects to join hands for a cooperative action on Dark Matter. An expression of interest call that was launched during JENAS 2019 https://jenas-2019.lal.in2p3.fr/- is the precursor for this particular activity.
The main goal of this initiative is to establish a broad platform, exploiting synergies and complementarities across different communities, which will be done in collaboration with ESCAPE.

- ## WP2 DIOS

The plan for the next 6 months (Feb 2020 – Aug 2020) will focus on three main activities

1) Consolidate the data lake prototype, instrument regular availability testing define operational procedures. The ESFRI projects should be able to ingress/egress their data to/from the data lake reliably and define data management policies by the end of the period.
2) Demonstrate the capability to process data stored in the data lake using real applications from the ESFRI projects. This will include the possibility to stage data from archival media.
3) Progress with the R&D activity and pilot the more innovative aspects of the data lake such as storage Quality of Service

Meeting those three objectives will put WP2 in a very strong position to accomplish Milestones 2.2, 2.3, 2.4 and produce the deliverable D2.2

In addition, in this period we plan to progress the process of publishing data lake services in the Service Catalogue (working with WP3), in integrating the data lake with the science platform (WP5) and with the Virtual Observatory (WP4).

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- WP3 OSSR

Until the mid-term review, the work will be carried out along the well-laid lines of the deliverables and milestones of the project, as well as the detailed project plan. In particular the following activities are planned:,

- The software and service list in D3.2 will be reviewed for common requirements and cross-fertilisation goals, as well as for completeness; additions will be stimulated where missing contributions are identified (M14);
- The conceptual design of the repository will be described and implemented; a few available open source software from the partners will be added as use cases and via this, necessary improvements identified (D3.3);
- The innovative competence group will be formed and a workshop on innovative workflows organised. (D3.4);
- The first ESCAPE summer school will be held to promote project development in the community;
- the test science cases of multi-messenger analysis workflows as well as the workflows for CORSIKA simulations will be finalised.

- WP4 CEVO

The work for the next 6 months (February – August 2020) is well defined by the detailed project plan, and has been refined during the WP4 Technology Forum event.

Many aspects of the work started in the first year will gathered into deliverable reports, namely the Intermediate Report on the use of IVOA standards (D4.2, March 2020) and the Intermediate analysis report of VO data and service integration into EOSC (D4.4, July 2020). The first “Science with interoperable data school’, will also be held on 26-28 May 2020 at the INTA partner in Madrid, with the deliverable (D4.3) report to be prepared before end of July 2020.

The next period also includes the next Milestone MS22 “Progress and Priorities at IVOA (3)”, which is associated with the IVOA interoperability meeting to be held 4-8 May, Sydney, Australia. Given the distant location the participation is expected to more limited than at IVOA meetings held in Europe, so we made sure to prepare the ESCAPE participation in the IVOA meeting during the Technology Forum in February. (The following IVOA Interoperability meeting will fortunately be in Europe again 13-15 November, 2020)

- WP5 ESAP

The plan for the next six months (February – August 2020) is to deliver the ESAP Minimum Viable Product prototype (MVP). ASTRON is currently developing the ESAP User Interface (UI) and Application Programming Interface (API) Gateway. In the first week of April, we will organise an ESAP busy week where developers from ASTRON, CERN, SKAO and UEDIN will meet in Dwingeloo, The Netherlands, to integrate the ESAP API Gateway with IVOA tools (WP4) and Rucio, the data lake orchestrator chosen by WP2. The busy week will result in the first ESAP prototype meeting the requirements of M5.3 “Initial science platform prototype with discovery and data staging”.

After M5.3 is achieved, we will continue with deploying the initial set of ESFRI software (*e.g.* the LOFAR software stack and DIRAC workload management system) on the prototype platform (M5.4). The upcoming milestones are expected to be reached on time.

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- WP6 ECO

The Exploitation Plan will be developed within the work packages in collaboration with the participating partners. We will also request the project partners to exploit these results and provide necessary feedbacks. The ESCAPE Dissemination and Exploitation Plan is effectively a "Living document", which will be adapted according to the evolving context in which ESCAPE is positioned. The science exploitation of Citizen Science mass participation experiments will be embedded within the crowdsourcing experiments.

Table 3 SWOT Analysis based on the first year activities

Internal		**External**	
Strengths	**Weaknesses**	**Opportunities**	**Threats**
Active interactions with ESFRI projects, concerned consortia and EOSC stakeholder projects.	Uncertainty on the sustainability of the services produced during the project lifetime.	Science driven approach with enhanced researchers' involvement for the EOSC implementation.	Lack of clarity on the EOSC architecture and how the ESCAPE services will plug into EOSC.
Diversity of partners representing different research fields and infrastructures	Diverse group with different backgrounds and different practices regarding open software/service products	Be part of defining the EOSC bringing in the community point of view.	Goals and timeline of the EOSC in general not yet defined in detail
Excellence of partner institutes and persons	Large number of partners	Interest from other communities to join the (e.g. HSF)	Expectations on EOSC very high as compared to commercial cloud solutions
Diversity of partners providing use cases from different research fields and infrastructures.	RI resources are distributed and local to each RI.	Contributing in shaping EOSC services.	Local RI resource may not be allocated for testing the platform.
Several partners have compute resources.	Compute resources are not clearly identified in the project proposal.	Use EOSC services such as EGI connected compute sites.	No clear commitment plan from partners with compute resources yet.

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5. Expected project impacts

The information on expected impacts as described in the DoW is still relevant and up to date.

6. Update of dissemination and exploitation plan

No update needed with respect to the present dissemination and exploitation plan (D6.2).

7. Update of data management plan

No update needed with respect to the present data management plan (D1.3)

8. Deviations from Annex 1 (DoA)

- Dr. Simone Campana (CERN) was selected by the partners as scientific coordinator of WP2. Dr. Simone Campana will step down from this appointment on Feb 29th 2020 for professional reasons. Dr. Xavier Espinal (CERN) was proposed as a successor and the proposal was supported by the WP2 partners. He will start covering this role on March 1st 2020. No impact is expected on the overall project workplan.

9. Critical implementation risks and mitigation actions

Following table enlists risk identified in Annex 1 and if necessary give new mitigation measures.

Nr.	Description & status of Risk	Workpackage	Proposed risk mitigation measure
1	Project governance does not work (Low) Risk not materialized.	1	The partners forming the consortium have extensive experience in working on EC funded projects and understand the requirements they demand, also with respect to reporting and financial administration.
2	Project coordinator does not work (Low) Risk not materialized.	1	Governance structure in place to monitor and act.
3	Project management does not work (Medium) Risk not materialized.	1	Project coordinator and Governance structure in place to monitor and act.
4	Coordination with EOSC does not work. (Low) Risk not materialized.	1	Project coordinator, Governance structure and ESFRI facilities Supervisory committee in place to monitor and act in order to associate ESCAPE to all EOSC current (such as EOSC-hub) and future projects and to take part to any scientific strategy committee for the implementation of the ESOC agenda.
5	Dissemination and outreach does not	1	CNRS (lead) has a good record on outreach and dissemination and has an interest in making the

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	reach far enough (Low). Risk not materialized.		project well known to everyone. Furthermore, the coordination with the outreach offices of each ESFRI facility involved in ESCAPE optimises the dissemination impact.
6	Performant and scalable data lake not being able to serve multiple RIs simultaneously. (Low) Risk not materialized.	2	Build on many years' experience in WLCG in data and storage federations, with existing and demonstrated solutions, integrating these with a coordination and service layer.
7	Lack of maturity and uptake of underlying technologies required; such as European-wide AAI services. (Low) Risk not materialized.	2	Collaborate with and set requirements for ongoing actions and projects: for example, AARC, EOSC- hub, EOSCpilot, GEANT etc.
8	Difficulty in integrating ad-hoc storage solutions at data centers into a coherent federated service. (Low*) Risk not materialized.	2	The core data centres selected bring several different and widely used storage solutions to the project; previous expertise of the partners (CERN, DESY, INFN) in building large-scale storage will address this.
9	Access to external HPC and cloud resources to support and validate data-heavy workflows is essential, missing HPC and cloud environments to support exascale data processing capabilities. (Low) Risk not materialized.	2	Collaborate strongly with PRACE for HPC, HNSciCloud partners for cloud, and GEANT for data access.
10	Lack of ICT infrastructures to deploy software and services repository. (Low). Risk not materialized.	3	Assessment via D3.3 and M3.4; Mitigation via the ESFRI/RI facilities and the ESCAPE project partners themselves that operate major computing facilities (CERN, CNRS, INFN). Influence possible via the work package management and the ESCAPE management including the ESFRI projects supervisory committee.
11	Lack of cross-fertilization and coherence in software and services. (High)	3	Assessment via D3.5 and M3.3; Mitigation via pro-active action of the help desk, the work package management, and the E-EB. Regulations of standards set by the EOSC and in

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	Risk not materialized.		ESCAPE have to be followed which reduces the risk.
12	Innovation activities with limited impact. (Medium) Risk not materialized.	3	Assessment via D3.5; Mitigation via assessment and steering of activities by WP3.4 competence group, gathering the know-how of all ESFRI/RIs. Work package management, together with the E-EB, will ensure developments with limited impact will be minimized, and new approaches opened, further cooperation with private companies can be used to stimulate the innovation impact.
13	Lack of availability or immaturity of underlying core EOSC services. (Medium) Risk not materialized.	3	Establish collaboration with EOSC-hub and EOSC pilot activities to identify and track current EOSC capabilities. Adjust ESCAPE WP3 development priorities as necessary.
14	EOSC does not meet the needs of the ESFRI. (Low) Risk not materialized.	4	Use ESCAPE participation in EOSC to bring requirements and feedback so that developers and users of EOSC can work towards convergence *State of play:* WP4 is actively participating in EOSC and has established contacts on the initial set of topics, in particular for Task 4.1. As EOSC is evolving quickly WP4 will continue to actively participate to understand (and contribute to) the development of EOSC and monitor the risk.
15	Difficulty to align the international IVOA priorities with those arising from ESCAPE. (Medium). Risk not materialized.	4	ESCAPE partners have leading roles in the IVOA and Task 4.2 ensures representation of european priorities in IVOA. *State of play:* As detailed in the Milestone reports (MS21, MS22) the representation in IVOA meetings in the first year of the project has been strong, and the priorities of IVOA are well aligned with those of ESCAPE. This has been facilitated by recent IVOA meetings being held in Europe. The May 2020 IVOA is less accessible being in Sydney, Australia. The Technology Forum approach mitigates this by preparing the input so that the ESCAPE priorities are represented even if by fewer participants.
16	EOSC operational framework is delayed. (Medium) Risk not materialized.	4	Use an incremental adoption plan for the use of EOSC. *State of play*: No relevant delays detected so far.
17	Poorly defined requirements on Science Platform functionality to support ESFRI science. Science Platform fails to meet the needs of	5	Develop well-defined set of ESFRI-specific use cases with clear inputs and testable requirements.

	the ESFRI communities. (Low) Risk not materialized.		
19	Lack of availability or immaturity of underlying core EOSC services. (Medium) Risk not materialized.	5	Establish collaboration with EOSC-hub and EOSC pilot activities to identify and track current EOSC capabilities. Adjust ESCAPE WP5 development priorities as necessary.
20	Insufficient ICT infrastructure available to support Science Platform deployment and testing. (Low) Risk not materialized.	5	Collaborate with ESFRI partners and associated data centres to define and establish dedicated resources for Science Platform.
21	Insufficient crowdsourcing ideas suggested from ESCAPE facilities and their pathfinders/precursors. (Low) Risk partially materialized.	6	The ESCAPE partners have already identified several potential citizen science projects, including: an extension to Galaxy Zoo to the ESO VISTA Hemisphere Survey or the ESO VST ATLAS; using these data to crowdsource a search for gravitationally lensed quasars; searching for rare Galactic objects in ESO VISTA VPHAS+; find optical identifications of radiogalaxies in forthcoming LOFAR data; classify them as Faranoff-Riley type I / II; trace the lines of their radio jets; crowdsource parts of the SKA Data Challenges; crowdsource classification challenges in FAIR; extending the successful H2020-funded Muon Hunter citizen science experiment to other VERITAS event classification. State of play: As foreseen, we have not been short of suggestions for crowdsourcing ideas. We have already launched one citizen science experiment, Galaxy Zoo Clump Scout. Furthermore, one of the suggestions implicit in the risk mitigation measures (entirely independently of the ESCAPE risk management) has since attracted a very wide discussion within the radio community, which has led to a new ESCAPE Zooniverse experiment that is currently being beta-tested by volunteers, Radio Galaxy Zoo: LOFAR. Partner organisation OU is also co-producing a prime-time astronomy BBC series for likely transmission in 2021 titled The Universe, and we are in discussion with the BBC production team about the possibility of citizen science viewer activities, with many possibilities for crowdsourcing experiments under consideration in this context.

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- Unforeseen risks

Risks acknowledged in the first 12 months of the project are listed in the following table.

Nr.	Description of Risk (Level)	WP	Proposed risk mitigation measures
1	Difficulty to find suitable contract staff (Medium)	3,4	Advertisements for contractual positions are to be distributed as widely as possible using the channels of the ESCAPE project.
2	Hired contract staff depart prematurely (Medium)	3,4	The partners will manage their contract personnel and indicate any risks if they arise to the WP management (Task 3.1).
3	Compute resources are not clearly identified in the project proposal.	2/3/5	Not needed. As the involved work packages have foreseen this issue and asked infrastructure providers involved in ESCAPE to contribute some compute resources for prototyping and demonstration purposes. Many infrastructure providers reacted positively to the call.

10. Dissemination & exploitation of results

Dissemination activities carried out in the first year of the project are available on the following link

https://cloud.escape2020.de/index.php/apps/onlyoffice/s/6O0F44Xcg5s9pKT?fileId=1197

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Annex 1: Terminology

Term	Explanation
AARNET	Australia's Academic and Research Network
ASTERICS	Astronomy ESFRI & Research Infrastructure Cluster
ASTRON	The Netherlands Institute for Radio Astronomy
CNRS	Centre national de recherche scientifique
CERN	European Council for Nuclear Research
CEVO	Connecting ESFRI projects to EOSC through VO framework
CTA	Cherenkov Telescope Array
CS	Citizen Science
DIOS	Data Infrastructure for Open Science
DMP	Data Management Plan
ECFA	European Committee for Future Accelerators
ECO	Engagement and Communication
EEAB	ESCAPE External Expert Advisory Board
EEB	Escape Executive Board
EGO	European Gravitational Observatory
ELT	Extremely Large Telescope
ESA	European Space Agency
ESCAPE	European Science Cluster of Astronomy & Particle Physics ESFRI research infrastructures
ESFRI	European Strategy Forum on Research Infrastructures
ESO	European Southern Observatory
EST	European Solar Telescope
EOSC	European Open Science Cloud
ESAP	ESFRI Science Analysis Platform
EUDAT	European Data Infrastructures
FAIR	Findable, Accessible, Interoperable, reusable
FAIR	Facility for Antiproton and Ion Research

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FAU	Friedrich–Alexander University
H-LHC	High Luminosity LHC
HPC	High-Performance Computing
IFAE	Barcelona Institute of High Energy Physics
IN2P3	Institut national de physique nucléaire et de physique des particules
INFN	Instituto Nazionale di Fisca Nucleare
IVOA	International Virtual Observatory Alliance
KM3NeT	Cubic Kilometre Neutrino Telescope
JIVE	Joint Institute for VLBI ERIC
LAPP	Laboratoire d'Annecy de Physique des Particules
MIND	Management, Innovation, Networking and Dissemination
MPE	Mass participation experiment
Nukhef	Dutch National Institute for Subatomic Physics
NuPPEC	Nuclear Physics European Collaboration Committee
OSSR	Open-source scientific Software and Service Repository
PRACE	Partnership for Advanced Computing in Europe
RDA	Research Data Alliance
SKA	Square Kilometre Array
TSP	Test Science Project
XDC	eXtreme DataCloud
VO	Virtual Observatory
WLCG	Worldwide LHC Computing Grid
WP	Work Package

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