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D4.1 – DETAILED WP4 PROJECT PLAN

Work Package	WP4, Connecting ESFRI projects to EOSC through VO
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0.90	12.07.2019	M. Allen, F. Genova (CNRS), M. Molinaro (INAF) with input from all WP4 partners	Complete draft updated with final input from WP4 partners. Provided to the ESCAPE Project Manager.

Disclaimer

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Table of contents

Acronym list

ADASS: Astronomical Data Analysis Software and Systems

ADQL: Astronomical Data Query Language

ALMA: Atacama Large Millimetre Array

ASTERICS: Astronomy ESFRI & Research Infrastructure Cluster

CERN: European Organization for Nuclear Research

CEVO: Connecting ESFRI projects to EOSC through the Virtual Observatory framework (ESCAPE Work Package 4)

CNRS: Centre National de la Recherche Scientifique

CNRS-ObAS: CNRS - Observatoire Astronomique de Strasbourg

COAM: Common Observation Archive Model

CPPM: Center for Particle Physics of Marseille

CTA: Cherenkov Telescope Array

CTAO: Cherenkov Telescope Array Observatory

DADI: Data Access, Discovery and Interoperability (ASTERICS Work Package 4)

EGO-Virgo: European Gravitational-Wave Observatory

ELT: Extremely Large Telescope (was E-ELT)

EM: Electromagnetic

EOSC: European Open Science Cloud

EOSC-Hub: Integrating and managing services for the European Open Science Cloud

EPN-TAP: Europlanet Table Access Protocol

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

EVN: The European VLBI Network

EWASS: European Week of Astronomy and Space Science

FAIR: Findable, Accessible, Interoperable, Reusable *or* Facility for Antiproton and Ion Research

FITS: Flexible Image Transport System

GPU: Graphical Processing Unit

HARPS: the High Accuracy Radial velocity Planet Searcher

HiPS: Hierarchical Progressive Survey

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HITS: The Heidelberg Institute for Theoretical Studies

HL-LCH: Civil engineering for the High-Luminosity

INAF: Istituto Nazionale di Astrofisica

INTA: Instituto Nacional de Tecnica Aeroespacial

IR: Infra-Red

IVOA: International Virtual Observatory Alliance

JIVE: Joint Institute for VLBI ERIC

KIS: Kiepenheuer Institut für SonnenPhysik

KM3NeT: A multi-km3 sized Neutrino Telescope

LSST: Large Synoptic Survey Telescope

NWO-I-ASTRON: the Netherlands Institute for Radio Astronomy

ObsCore: Observation Core Data Model

ObsParis: Observatoire de Paris

RDA: Research Data Alliance

RI: Research Infrastructure

ROB: Royal Observatory of Belgium

SAMP: Simple Application Messaging Protocol

SKA: Square Kilometre Array

SKAO: Square Kilometre Array Organisation

TAP: Table Access Protocol

TAP/ADQL: Table Access Protocol/Astronomical Data Query Language

UCDs: Unified Content Descriptors

UEDIN: University of Edinburgh

UHEI: Ruprecht-Karls-Universität Heidelberg

UV: Ultraviolet

VLBI: Very-long-baseline interferometry

VO: Virtual Observatory

WG: Working Group

X-Match: CDS Catalogue Cross-Match Service

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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 (SKA, CTA, KM3Net, EST, ELT, HL-LHC, FAIR) as well as other pan-European research infrastructures (CERN, ESO, JIVE) 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-messenger facility 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 principles. These joint efforts are expected 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 integrate the EOSC catalogue with a dedicated catalogue of open source analysis software. This catalogue will provide researchers across the disciplines with new software tools and services developed by 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.

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Executive Summary

This document describes the detailed project plan for ESCAPE Work Package 4, CEVO (Connecting ESFRI projects to EOSC through VO framework). This plan will serve as the work plan at the beginning of the project, and will be adapted throughout the duration of the project based on the progress and initial results. The plan is to serve as a guide to the partners in Work Package 4 for the organisation and monitoring of the work done in each of the partner institutes.

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 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. The project plan provides high level descriptions of all of the tasks. Detailed descriptions of the tasks and sub-tasks are tabulated. These tables will be used to track progress throughout the project, and the tables are cross-referenced with the milestones and deliverables that each task contributes to. 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 tabulated and are linked to the relevant ESFRI and RIs. The preparation plan for the initial set of events associated with this main task is outlined. The management task covers the coordination of the various activities in WP4, as well as overall coordination with the other work packages in ESCAPE. The roles of each partners are described and includes a list of the main contacts for each partner. The schedule of the work package is shown as a full calendar with deliverable and milestone dates, plus a table of the major IVOA meetings during the project. The planned person-month effort is shown for each partner with the expected contribution of each partner to the various tasks. A table of the full set of deliverables with type, lead participant, and delivery month is provided. An updated risk register is also provided.

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1. Introduction

Work Package 4 of ESCAPE, "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 Virtual Observatory framework.

The Virtual Observatory is a framework of open standards for making astronomy data FAIR. It is an established and operational interoperability framework that has proven to be a great success for many aspects of the interoperability and FAIRness of astronomy data. It is an essential component of the astronomy data landscape, as has been strongly stressed in the ASTRONET Infrastructure Roadmap since its first publication in 2008. International astronomy data providers, in particular ground- and space-based observatories, publish their data using the IVOA standards, and compliant scientific tools and services enable the discovery, access and use of the data by the whole astronomy research community.

The inclusion of the data of the ESFRI facilities from astronomy and astroparticle physics in the VO is already well advanced thanks to the collaboration between ESFRI pathfinders and European VO teams in the ASTERICS Data Access, Discovery and Interoperability (DADI) Work Package since 2015. **The CEVO objectives build on these developments to make the seamless connection of ESFRI and other astronomy research infrastructures to the EOSC through the VO.** The astronomy and astroparticle VO data and services will become part of the EOSC, and will be significantly extended by the inclusion of new partners in the wider context of ESCAPE, and the new opportunities provided by EOSC. By leading the connection to the EOSC with the ESFRI we will set the path for a new era of cross-disciplinary interoperability, and connections to the necessary computing resources. EOSC will facilitate the next step for the VO framework to realise its potential to scale to the biggest data sets that will be produced in particular by the ESFRI projects, and (via coordination with WP5) will enable use of VO data in scientific analysis platforms.

The high-level objectives of CEVO are to:

- Assess and implement the connection of the ESFRI and other astronomy Research Infrastructures to the EOSC through the Virtual Observatory 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.
- Establish data stewardship practices for adding value to the scientific content of ESFRI data archives.

CEVO brings together ESCAPE partners who have expertise in the VO framework, with partners who are connected to the ESFRI projects and other research infrastructures. The VO expertise is provided by the partners: CNRS-ObAS, INAF, INTA, UEDIN, UHEI who have built up the Euro-VO alliance of national European projects since 2002. ObsParis has become a VO expert during the ASTERICS project and brings a special link between VO and the Cherenkov Telescope Array. The ESFRI and other research infrastructures who are directly involved in CEVO are: the ESFRI projects: the European Solar Telescope (EST), and the cubic-kilometre-sized Neutrino Telescope (KM3NeT); the ESFRI landmark projects: Cherenkov Telescope Array (CTA), Extremely Large Telescope (ELT) and the Square

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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 ESCAPE partners that are participating in the CEVO work package, and their connection to the ESFRI or other RIs are listed in the CEVO Partners table below.

CEVO Partners:

ESFRI/RI or VO	CEVO Work Package Partner
CTA	**CTAO** (Cherenkov Telescope Array Observatory)
CTA / VO	**ObsParis** (Observatoire de Paris)
EGO-Virgo	**EGO-Virgo (**European Gravitational Observatory)
ELT / ESO	**ESO** (European Southern Observatory)
VLBI ERIC	**JIVE** (Joint Institute for VLBI ERIC)
EST	**KIS** (Kiepenheuer Institut für Sonnenphysik)
EST	**ROB** (Royal Observatory of Belgium) / **ORB** (Observatoire Royal de Belgique)
SKA	**SKAO** (Square Kilometre Array Organisation)
SKA	**NWO-I-ASTRON** (the Netherlands Institute for Radio Astronomy)
KM3NeT	**CNRS-CPPM** (Center for Particle Physics of Marseille)
VO	**CNRS-ObAS** (Observatoire Astronomique de Strasbourg)
VO	**INAF** (Istituto Nazionale di Astrofisica – Astronomical Observatory of Trieste)
VO	**INTA** (Instituto Nacional de Tecnica Aeroespacial)
VO	**UEDIN** (The University of Edinburgh)
VO	**UHEI** (Heidelberg University)
WP3 interface	**HITS** (The Heidelberg Institue for Theoretical Studies)

This document provides the detailed CEVO work plan as it stands at the beginning of the project. It provides a guide to all of the partners for the definition and control of the expected work. The work plan is expected to evolve over the course of the project. There are a number of activities that will depend on the progress of the EOSC, and on the initial results from the early stages of the project, as well as on the establishment of the interfaces to the other different ESCAPE work packages.

This work plan includes a description of the CEVO Structure and Roles that are organized around the main tasks (Section 2), the Schedule and Resources (Section 3), and the Risk Analysis (Section 4).

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2. WP4 structure and roles

CEVO is structured into three main tasks plus a management task. Here we provide a detailed description of the tasks, identifying the initial steps and the approach for tracking and modifying the tasks throughout the project. For each of the tasks we provide a top-level description (consistent with the proposal) and identify the sub-tasks involved, and tabulate the envisaged steps that are involved to carry out the task. The tables will be used to track progress and will be adapted according to changes during the progress of the project.

Task 4.1 - Integration of astronomy VO data and services into the EOSC

Aim: Map the VO framework to EOSC to include the VO enabled archive services from ESFRIs in the EOSC.

High level description:

This task will identify the domain specific data access, discovery and manipulation standards and integrate them with the EOSC platform. The task will work on the provisioning and operation of dedicated customized EOSC services that implement the IVOA standards. In particular, this task will define the set of VO-enabled services to be included into ESOC by customizing EOSC services, with the aim of providing a high level of integration of VO tools, standards and best practices. A continuous analysis and integration, following the evolution of EOSC services and tools, is foreseen.

Detailed tasks:

4.1.a - Interfacing the VO framework with the EOSC.

Inclusion of the VO registry into the EOSC service catalogues to allow EOSC users to identify Astronomy-specific services.

Identify the relevant contacts for EOSC service catalogues and registry related aspects (including B2FIND).	
Assess information provided by EOSC to identify the possible pathways for service providers to enter their services into the EOSC service catalogue and determine an approach to include the VO registry.	
Participate in the IVOA Registry WG to inform the global IVOA community about EOSC catalogues, and to identify technical aspects of IVOA registry operations relevant to their inclusion in EOSC.	
Identify the VO Registry test-bed systems to be used in preparation for inclusion in EOSC.	
Establish a timeline for the inclusion of the VO registry into EOSC.	
Assess the use of EOSC vocabulary services for the inclusion of established astronomy vocabularies *(dependent on EOSC development)* for use in cross-disciplinary discovery services.	
Participate in all relevant EOSC project events (EOSC-Hub, FREYA, OpenAIRE-Advance, FAIRsFAIR)	

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4.1.b - Build an Astronomy Portfolio of VO services to be contributed to the EOSC Marketplace

Assess the methods for contributing VO services as an Astronomy Portfolio to the EOSC Marketplace.	
Analyse the possibilities for operating a customized marketplace for astronomical VO services.	
Establish a test plan for contributing selected VO services to the EOSC Marketplace *(dependent on the results of the above steps).*	

4.1.c - Contribution to EOSC Hybrid Cloud by federating astronomy data centres.

Assess the available solutions for federating data and computing infrastructures for compute- and data-intensive applications (for computing close to the data), e.g. DataHub.	
Perform a study of accessing VO-compliant data and services using science analysis platforms *(in coordination with WP5).*	
Assess the possible implementation of existing VO standards for data sharing (VOSpace) within the EOSC services.	

4.1.d - Containerised domain-specific services

Web-based remote analysis tools will be tested on the EOSC Cloud and if possible contributed to the EOSC applications and services database.

Identify existing VO services or tools to serve as test-cases for containerization.	
Establish a timeline for the contribution of successfully tested services to be contributed to the EOSC applications and services database.	
Test the harmonisation of the above mechanisms with the design and implementation of a "data lake" *(in coordination with WP2)*.	

Related Deliverables and Milestones for Task 4.1:

D4.4 Intermediate analysis report on integration of VO data and services into EOSC (Report).	Month 18 July 2020
D4.7 Final analysis report on integration of VO data and services into the EOSC (Report).	Month 38 March 2022

Task 4.2 – Implementation of FAIR principles for ESFRI data through the Virtual Observatory

Aim: The definition and adoption of common open IVOA standards for interoperability based on ESFRI requirements

High level description:

This task will identify the ESFRI needs for common standards to enable high level data products and archive services to be interoperable in the VO framework, so that they can connect to the EOSC through the VO. The task will support the adoption of the VO framework and participation in IVOA for the definition and updates of the necessary standards, in particular for the inclusion of new communities introduced by ESCAPE. A practical problem-solving platform will be established where VO expertise is shared and developed. The scientific community will be supported in the use of FAIR data via VO tools and services in training events, including new capabilities enabled by the inclusion in EOSC.

Detailed Tasks:

4.2.a - Gathering of requirements from ESFRIs for their use of the VO framework and its connection to EOSC.

Gather requirements from each ESFRI and RI for their use of the VO framework and its connection to the VO – dedicated meetings with each ESFRI and RI.	
Identify the initial priorities for each ESFRI and RI and introduce and match these requirements to the priorities set at the international level by IVOA .	
Introduce new participants for interoperability into the VO (in particular EST), and assess the federation of the various existing and desired interoperability systems.	
Establish and continuously update a plan for implementing VO interoperability for each ESFRI or domain specific area (Solar Physics, Interferometric data, event-based data, UV/Optical/IR data,) and overall for multi-wavelength and multi-messenger data.	

4.2.b - Update and definition of standards based on the requirements and priorities, and representation of ESFRI interests in the global VO framework.

Contribute to the update and definition of IVOA standards based on the ESFRI and RI priorities, and include the EOSC interface related aspects where applicable.	
Participate in all IVOA interoperability meetings (bi-annual international meetings of the global IVOA community) – for the planning and definition of the relevant IVOA standards.	
Preparation of Milestone reports for each IVOA meeting, identifying ESCAPE participation and progress as well as general European contributions to IVOA. (M4.1, M4.2, M4.3, M4.4, M4.6, M4.7).	M4.1 done

4.2.c Establish a practical problem-solving platform to facilitate implementations and prototypes of interoperable access to ESFRI and pathfinder data.

Identify a group of experts to collect documented common solutions for the use of VO framework and EOSC for interoperability. Establish a web page and communication channel platform.	
Organize the practical hands-on training event for data providers associated with the platform (M4.5).	

4.2.d Support of the scientific community for the use of *FAIR* data

A user-centric approach will be taken to support the scientific community in their use of the FAIR data and capabilities enabled by the VO and its connection to the EOSC.

Make the interoperability standards actionable in data access and visualization tools for multi-wavelength and multi-messenger data	
Organize two hands-on scientific schools “Science with interoperable data” for early career scientists, with science-case tutorials (D4.3, D4.6)	
Maintain a repository of re-usable scientific training materials produced for the schools	
Engage with RDA working groups and interest groups to represent the interests of astronomy data sharing, and assess the applicability of RDA to increase Astronomy data *FAIR*ness.	

Task 4.2 plans related to each ESFRI and Research Infrastructure:

Here we outline the specific plans for each of the ESFRI and Research Infrastructures who are participating in CEVO. During the first 6-month ramp-up period of the project a number of first meetings and discussions have already been held to establish the initial approaches to gathering the requirements of the ESFRI and Research Infrastructure. It should be noted from the outset that there is a wide diversity in the plans and current states of the ESFRI and Research Infrastructures. Each one has its unique starting point for its desired use of the VO framework, and subsequently different aspirations and goals for the use of the EOSC through the VO framework.

A number of the ESFRI and Research Infrastructure partners have participated in ASTERICS DADI and have already integrated various aspects of VO into their plans, and operations. In these cases, the work of CEVO builds on the success of ASTERICS DADI and the way of working in Task 4.2 of CEVO will be very familiar because it uses the same approach as used in DADI. For the new partners in this endeavor there is of course the necessity to discuss all of the basic principles for use of the VO, and to establish the right approach that is appropriate for the stage of the development of the ESFRI or Research Infrastructure. For all of the partners involved in CEVO, the proposed developments are at the forefront of the data sharing needs. The interaction between the VO expert partners and ESFRI and RI partners will be the key to making relevant and innovative steps toward the implementation of FAIR principles.

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The following tables show the activities planned for each ESFRI and RI, grouped into specific domain areas of "Solar Physics", "Radio and Millimeter Astronomy", "High Energy Astrophysics", UV/Optical/IR Astronomy, "Neutrino Astrophysics" and "Gravitational Wave Astrophysics". These plans have been developed with the relevant CEVO partners, and due to the different levels of previous engagement and status, there are different levels of detail in the different domain areas. As such, these tables represent the starting points for the CEVO activities, and by design these plans will be continuously updated during the project based on the progress and the initial results.

Solar Physics: EST – European Solar Telescope	
Solar physics thematic extension to the EPN-TAP protocol. - Review existing parameters and identify required parameters to include in EPN-TAP for solar physics. - Identify the necessary Unified Content Descriptors (UCDs) for solar physics. - Test the practical linking of exiting metadata to corresponding UCDs. - Coordinate the solar physics community effort for agreement on UCDs. *(Part of Tasks 4.2.a and 4.2.b. Contributes to D4.2)*	

Data Access Layer for solar physics data sets.
- Implementation of a TAP service (for data sets managed by ORB) using the thematic extension to EPN-TAP from above Integrate the TAP service within the existing SOLARNET Virtual Observatory.
- Linking the query language from ORB Event Database with ADQL.
- JHelioviewer improvements for VO interoperability. This includes study and test implementation of VOTable, TAP/ADQL and SAMP.
  ○ Linking JHelioviewer with ORB Event Database.
  ○ Linking JHelioviewer with SOLARNET VO.
(Part of Task 4.2.a and 4.2.b, potential application in training events of 4.2.d. Contributes to D4.2, D4.8)	

Data discovery for solar physics data. - Linking solar Event Database resources with SPASE. A challenging and exploratory effort to bridge Solar VO and IVOA standards to improve interoperability (dependent on results of the extension to EPN-TAP) *(Part of Tasks 4.2.a, 4.2.b and 4.2.c. Contributes to D4.8)*	
VO data discovery for multi-dimensional solar data at KIS - Assess and test the use of IVOA Observation Core Data model (ObsCore) for multi-dimensional solar physics data at KIS - Develop detailed requirements for multi-dimensional solar data (spectral, polarization, time, spatial axes) *(Part of Tasks 4.2.a, 4.2.b and 4.2.c. Contributes to D4.2, D4.8. Potential application in training events of 4.2.d.)*	

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Radio and mm Astronomy – SKA, JIVE, LOFAR, ALMA	
SKA *(coordination of SKAO and ASTRON as co-representatives of SKA within ESCAPE)*	
Gathering requirements for SKA: - Identification of the basic VO building blocks required for the VO compatibility and use of the data that will be produced by SKA. *(Initial discussions have been held in the context of ASTERICS-ESCAPE transition events, but further dedicated meetings are required).* ○ Initial topics include: Observational Core Data Model (and its implementation via the COAM), the VO Provenenance scheme, Authorisation and Authentication, HiPS for image data products and simulation. - Identification and analysis of the VO components that will require scaling for use with data produced by SKA. - Development of the approach for SKAO to address the requirement that SKA Regional Data Centres be VO compliant. Development of use cases: - For publication of data and simulations using the VO. - For use of SKA data with other data and services. - For cross-WP activities in particular for use of VO enabled data and services through the WP5 Platform. *(Part of Tasks 4.2.a, 4.2.b. Contributes to D4.2, D4.8.)*	
Capacity building in SKAO on the topic of VO expertise - Identify the IVOA standards and tools relevant to SKA and build up knowledge with and examples-based approach. *(Results to be contributed to the "Problem solving Platform" and feedback during the Hand-on workshop for data providers event M4.5)* *(Part of Task 4.2.c. Contributes to D4.2, D4.8)*	
Exploration and testing of VO capabilities for simulated images - Test the use of VO HiPS technologies for simulated images (developing the concept that real and simulated data be interoperable in the same system) *(Part of Task 4.2.b and 4.2.c, contributes to D4.2, D4.8. Potential application in training events of 4.2.d)*	

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JIVE	
Develop the concept of Radio Astronomy UV data in the VO - Contribute to the development of IVOA standards to enable interferometric data in the VO - Participate in IVOA to provide feedback on common standards relevant to radio astronomy *(Part of Tasks 4.2.a 4.2.b, contributes to D4.2, D4.8.)*	
Implement VO services for the EVN archive - Build up expertise on the implementation of VO standards, libraries and tools for use in the EVN archive - Implementation of VO data access standards for the EVN archives - Register JIVE resources in the VO registry *(Part of Tasks 4.2.a 4.2.c, contributes to D4.2, D4.8. Potential application in training events of 4.2.d)*	
LOFAR	

Participation in IVOA to provide input and feedback on common standards relevant to radio astronomy.
- Mapping of the LOFAR metadata to the IVOA Observation Core Data Model.
 	
Gathering requirements for the use of VO standards and tools for LOFAR data.
- Identify the basic VO building blocks for VO compatibility of LOFAR data. *(Initial discussions have been held in the context of ASTERICS-ESCAPE transition events, but further dedicated meetings are required).*
  o The initial topics include: Common standards, formats, data model, data provenance, and goals for interoperability.
 	
Development of use cases for:
- Data discovery of visibility data sets based on LOFAR metadata.
  o e.g. based on antennae configuration details.
- Standardized description of visibility data sets to facilitate data selection.
 	
(Part of Tasks 4.2.a 4.2.b, contributes to D4.2, D4.8.)	

ALMA	
Assess usage of VO standards to enable access to ALMA data. (Involvement of ALMA data in Task 4.3.a) *(Part of Tasks 4.2.a 4.2.b, contributes to D4.2, D4.8.)*	

High Energy Astrophysics - CTA	
Extend and implement the VO Provenance Scheme to fit the needs of ESFRI projects and scientific research. - Explore the use of the VO Provenance scheme in the context of multi-messenger astrophysics and transients, and its use with VOEvent systems. - Contribute to extension of the VO Provenance scheme for other ESFRI projects. *(Part of Task 4.2.a, 4.2.b. Contributes to D4.2, D4.8)*	
Develop and collect use cases (CTA and beyond) for inter-observatory astronomy in the multi-messenger context *(in coordination with WP5).* - Develop use cases related to multi-messenger and multi-wavelength astronomy based on VO. - Identify the future workflows and their requirements in the era of transient facilities (e.g. LSST, SKA, CTA). - Identify requirements for and links to services for correlation of multi-messenger science alerts based on VO. *(Part of Task 4.2.a. Contributes to D4.2, D4.8)*	

Develop VO Data Models relevant to CTA and for multi-observatory astronomy in the multi-messenger context.
- Contribute to the definition of Data Models to support multi-observatory observations and scheduling.
- Contribute to Data Models for high level data relevant to CTA (VOEvents, VOTables) and other ESFRIs.
  ○ Revision of implementations of VO data models in FITS, HDF5, and other formats *(collaboration to be facilitated with KM3NeT partners).*
  ○ Revision of the VOEvent data model definition.
  ○ Investigation of VO data models for (high-level) simulations
- Visualisation of multi-messenger data model (incl. provenance) and workflows in the context of VO *(in coordination with WP5)*
(Part of Task 4.2.a, 4.2.b, 4.2.c. Contributes to D4.2, D4.8)	

Contribute to the scientific training events. - Development of tutorials dedicated to CTA users for the VO schools. *(Part of Task 4.2.d. contributes to D4.3, D4.6)*	
Description of CTA VO services for their connection to EOSC - Describe the CTA data in preparation for VO connection to the EOSC. - Test implementation of the CTA VO archive within the EOSC catalogue. - Explore implications to (CTA and other ESFRI) data centres of being VO compliant. *(Part of Task 4.1.a, 4.1.b. contributes to D4.4, D4.7)*	

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Optical/UV/IR astronomy - ESO	
Identification of priorities for use of the VO framework and the EOSC relevant to Optical/UV/IR astronomy archives via the definition of use cases for: - Time domain and alerts; multi-messenger astronomy. - Access authentication (e.g. for proprietary or non-public commissioning data) and single sign on systems *(in liaison with Task 4.1*	
Maintenance and evolution of the IVOA standards and Virtual Observatory tools that are relevant to the ESO Science Archive. - The initial list of standards includes: ADQL 2.0, DataLink v1.0, ObsCore v1.1, SSAP v1.1, TAP v1.0; and the use of SODA is to be assessed. - The initial set of relevant tools includes taplib, SSAPServer, and Aladin Lite. *(Part of Task 4.2.a, 4.2.b, 4.2.c. Contributes to D4.2, D4.8)*	
Establish requirements and development plans for IVOA standards to support new functionalities for astronomy archives. The initial areas of interest are: - Standards for handling and accessing 3D data. - Standards and tools for cut-outs for 2D images and 3D cubes. - Standards for Solar observations, e.g. for the ESO HARPS instrument in HELIOS mode. *(Part of Task 4.2.a, 4.2.b, 4.2.c. Contributes to D4.2, D4.8)*	
Identify requirements for standardised description of value-added data. - Metadata for value-added data products including: Probability Distribution Functions (PDFs), object classifications and other derived quantities from machine learning applications to astronomy archive content. *(Part of Task 4.2.a, 4.2.b. Contributes to D4.2, D4.8. Related to products that will be produced in Task 4.3)*	

Neutrino Astrophysics – KM3NeT	
The general areas to be developed and adapted throughout the project in order to make a significant improvement in the use of common IVOA standard for KM3NeT include:	
Mapping of KM3NeT events/alerts information into the VOEvent standard. - Provide feedback to IVOA. - Explore the needs of KM3NeT users, and identify how to address them in the framework of VOEvent. *(Part of Task 4.2.a, 4.2.b, contributes to Deliverables D4.2, D4.8)*	
Archiving of KM3NeT events and associated information.	

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- Explore the use of VO standards for the archive system *(collaboration to be facilitated with CTA partners, and EGO and EST for alerts).* Initial priorities include: o Mapping of VOEvent and other information into VOTables. o Mapping of high-level data to VOTables and explore representations in FITS and HDF5 formats. o Development of techniques for handling the specific aspects of neutrino events, including sensitivities or simulated events to understand the data. o Explore the use of the VO Provenance scheme in the context of multi-messenger astrophysics and transients, and its use with VOEvent systems. *(Part of Task 4.2.a, 4.2.b, contributes to Deliverables D4.2, D4.8)*	
Automatizing VO search mechanisms for the identification of potentially interesting EM sources in VO accessible catalogues. - Use of APIs for existing services (SIMBAD, VizieR etc.). - Use cases for tools such as Aladin, TOPCAT, astropy and for IVOA protocols such as TAP, and cone search including time. - Tests of the cross-correlation between astrophysical catalogs (X-Match). *(Part of Task 4.2.a, 4.2.b, contributes to Deliverables D4.2, D4.8)*	

Gravitation Wave astronomy – EGO-Virgo	
Development of VO infrastructure and tools for GW events relevant to EGO-Virgo - Identify detailed requirements for the EGO-Virgo use of VO tools (Aladin and Aladin Lite) and for sky coverage systems (Skymap and HEALPix standards). - Prototyping of advanced all-sky visualization for GW events including IVOA standards – HiPS and MOC o Implementation of common standards for managing complex sky regions (in particular interoperability with the multi-order HEALPix maps produced by the LIGO/Virgo localization algorithms). o Prototype implementation in VO tools (GWsky). - Identify requirements for catalogues of GW events (and the use of localization information in catalogues). *(Part of Task 4.2.a, 4.2.b, contributes to Deliverables D4.2, D4.8)*	
Input to the development of VO standards relevant to gravitational wave astronomy. - Develop use cases for Time-Space-Multi-order coverage systems. - Exploration of GW data as a time series – for possible publication of the GW event wave-form as a time series using VO standards. *(Part of Task 4.2.a, 4.2.b,. Contributes to D4.2)*	
Update of tutorials for training events.	

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- Develop tutorials focused on multi-messenger use of VO tools in preparation for the training events. - Explore innovative use of visualization tools for GW information (with potential for use in WP6) (*e.g. sonificiation*). *(Part of Task 4.2.d. Contributes to D4.3)*	
Build the connection to EGO/Virgo/LIGO to foster use of common standards for gravitational wave astronomy. *(Part of Task 4.3.b*)	

Preparation Plan for the initial set of events related to Task 4.2:

IVOA Interoperability Meetings. - Coordination of the participation of CEVO partners in the IVOA Interoperability Meetings, including identification of priorities for ESFRI and RI partners, and maintaining a register of priorities. - Preparation of European input to IVOA, potentially by organising Technology Forum events preceding the IVOA meeting and coordinated with the problem-solving platform. *(Part of Tasks 4.2.a, 4.2.b, 4.2.c. Contributes to D4.2, D4.8, M4.2, M4.3, M4.4, M4.5, M4.6, M4.7)*	
1st and 2nd Science with interoperable data schools. (*Month 16, Month 35)* - Identification of topics for the school lectures and hands-on tutorials relevant to ESFRI and RI partners. - Preparation and updates of hands-on tutorials (*potentially using results from the first part of the project, i.e. new or updated services/data in the 2nd event).* - Support of the sustainable repository of training materials for re-use. *(Part of Task 4.2.d. Contributes to D4.3, D4.6)*	
Hands-on workshop for data providers. *(Month 28)* - Identification of priorities for data providers for making their data FAIR using VO and EOSC using an expert group from the partners. - Preparation of hands-on training materials for data providers. *(Part of Task 4.2.c. Contributes to D4.2, D4.8, M4.5)*	

Multi-messenger Common Challenges:

Assessment of common topics for multi-messenger astrophysics across various ESFRI/RIs. - Organize and track meeting points for topics related to multi-messenger astrophysics. - Identify points of contact for multi-messenger projects in the CEVO context. - Identify opportunities and topics for collaboration *(Initial connections are CTA-KM3NeT-EGO/Virgo).* *(Part of Task 4.2.c, Contributes to deliverable D4.8)*	

Related Deliverables and Milestones for Task 4.2:

D4.2 Intermediate analysis report on use of IVOA standards for FAIR ESFRI and community data (Report)	Month 14, March 2020
D4.3 First science with interoperable data school (Event and report)	Month 16, May 2020
D4.6 Second science with interoperable data school (Event and report)	Month 35, December 2021
D4.8 Final analysis report on use of IVOA standards for FAIR ESFRI and community data and best stewardship practices for value-added data (R)	Month 40, May 2022
M4.1 Progress and priorities at IVOA (1)	Month 5, June 2019
M4.2 Progress and priorities at IVOA (2)	Month 10, November 2019
M4.3 Progress and priorities at IVOA (3)	Month 17, June 2020
M4.4 Progress and priorities at IVOA (4)	Month 22, November 2020
M4.5 Hands-on Workshop for Data Providers	Month 28, May 2021
M4.6 Progress and priorities at IVOA (5)	Month 29, June 2021
M4.7 Progress and priorities at IVOA (6)	Month 34, November 2021

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Task 4.3 – Adding value to trusted content in astronomy archives

Aim: Pursue exploratory and innovative approaches to adding-value to the next-generation astronomy archives.

High level description:

ESFRIs and astronomical data centres are developing the next generation of functionalities to create and publish high-level value-added data products. Stewardship involving the creation and publication of these data is necessary to ensure their quality as a trusted resource. The application of new techniques such as machine learning and analytics will provide new capabilities. A common data stewardship culture for data produced by the ESFRIs and those generated and deposited by the community will lead to optimal exploitation of ESFRI data. This will be pursued by:

4.3.a - Assessing the application of machine learning classification and analytics for adding value to ESFRI archives

Define and develop prototypes for value-added data products and archive services using machine learning - A specific activity will be pursued for the ESO archive in coordination with machine-learning development in WP3.	

ESO archive specific activity:

An ambitious activity will be undertaken to explore the application of machine learning classification and analytics to provide new prototype capabilities for the ESO archive services. The overall goal is to use technologies and expertise drawn from the CEVO partners and the other ESCAPE Work Packages, to enable value-added content in a prototype service.

The initial steps include defining the scope of the activity, and to set out a number of directions to be explored in the first year of the project.

ESO Specific activity table

Identification of three axes for development relate to Spectra, Cubes and Catalogue data: - Spectral similarity: with the example of the ESO HARPS instrument data. - Exploration of morphology similarity in data cubes: with the example of the ALMA data cubes. - Object classification in astronomical source catalogues: with the example of ESO public survey catalogues.	
Definition of initial goals for prototypes and assessments of technologies - Machine learning techniques for spectral data sets using data from the ESO HARPS instrument *(December 2019).*	

- Visual prototypes for value added data *(December 2019).* - Review of initial year results and planning for years 2 and 3 *(Q2 2020).*	
Identify access to computing resources (GPU cluster) - Development of Machine learning algorithms at HiTS *(in coordination with WP3)* and ESO. - Computing resources associated with EOSC *(Depending on results of Task 4.1)(Expected in 2nd half of project after initial progress).*	
Definition of target audiences for prototype demonstrations. **Initial targets:** - VO School participants in "2nd Science with interoperable data school" (December 2021). - Conferences (e.g. ADASS, Astro-informatics, EWASS). - ESO Users Committee (April 2020). Definition of audience for event associated with deliverable D4.5 (July 2021). Establish a plan for feedback on the prototype services, and reporting of this feedback in deliverable D4.8.	

4.3.b – Identification of best practices for stewardship of next-generation data products including curation and publication via ESFRI archives

This sub-task is to define and initiate activities to help develop a common data stewardship culture for data produced by ESFRIs, and also for data generated and deposited by the scientific community. These activities are expected to evolve significantly during the course of the project, and the events are expected to be co-located with other CEVO, and general ESCAPE activities.

Identification and participation in events related to stewardship best practices. - Research Data Alliance (RDA) plenaries. - EOSC events. - Data stewardship in astronomy (e.g. Librarians and Information Scientists in Astronomy (LISA) conference expected in 2020). - ESO/ESA SCIOPS conferences.	
Participation in ESCAPE events where stewardship aspects can be developed (e.g. ESCAPE All-Hands meetings).	
Definition of methods to gather input on best practices from ESFRI, Research Infrastructures and all ESCAPE partners.	
Analysis of input on best practices.	
Define methods and scope for presenting the CEVO findings on best practices, and identification of how to best provide the feedback into the EOSC communities.	

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Related Deliverables and Milestones for Task 4.3:

D4.5 Release of prototype machine learning enabled archive services providing value-added content to archives (Demonstration)	Month 30 July 2021
D4.8 Final analysis report on use of IVOA standards for FAIR ESFRI and community data and best stewardship practices for value-added data (Report) *(includes report of feedback on prototype services developed for D4.5)*	Month 40 May 2022

Task 4.4 – WP4 Management

This task will provide the coordination of the various activities in WP4, as well as overall coordination with the other work packages in ESCAPE. It will be responsible for the following activities:

Development of the WP4 project plan (D4.1). - The work plan tables will be updated to track progress in the project, and will be reported in relevant annual reports.	
Coordination of the technical work in WP4 between the partners, and between tasks. - The ESCAPE IT Services project management tools will be used as necessary. - Videocon meetings every 3-4 months will be used to monitor progress of the tasks. - Individual contacts, and dedicated meetings at partner sites will be organized.	
Organizing the milestones and deliverables.	
Reporting on progress within the project. - Monitoring of the PM resources used by each partner will be done each 9 months as requested by the project (WP1).	
Coordination with other technical work packages. - To be done via participation of the WP4 lead in the ESCAPE Executive Board. - Coordination performed by the partners in their tasks is to be reported to the WP lead.	

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Roles of the partners in CEVO

Project	Partner	Name	Role
VO lead	CNRS-ObAS	Mark Allen	Lead of WP4 , co-lead of Task 4.3
VO	CNRS-ObAS	Françoise Genova	Lead of Task 4.2
KM3NeT	CNRS-CPPM	Paschal Coyle	CNRS-CPPM main contact
CTA	CTAO	Matthias Fuessling	CTAO main contact
CTA/VO	ObSParis	Catherine Boisson	ObsParis main contact
EGO	EGO-Virgo	Franco Carbognani	EGO-Virgo main contact
ELT	ESO	Martino Romaniello	ESO main contact, co-lead of Task 4.3
VO	INAF	Marco Molinaro Giulliano Taffoni	Lead of Task 4.1 Connection to WP2
VO	INTA	Enrique Solano	INTA main contact
JIVE	JIVE	Arpad Szomoru	JIVE main contact
EST	KIS	Nazaret Bello González	KIS main contact
SKA/LOFAR	NWO-I-ASTRON	Michiel van Haarlem	ASTRON main contact
EST	ORB	Véronique Delouille	ORB main contact
SKA	SKAO	Rosie Bolton	SKAO main contact
VO	UEDIN	Andy Lawrence Dave Morris	UEDIN main contact Connection to WP5
VO	UHEI	Joachim Wambsganss	UHEI main contact

The CEVO partners with VO expertise, namely CNRS-ObAS, INTA, INAF, UHEI, UEDIN and ObsParis will contribute across all of the CEVO Tasks 4.1, 4.2 and 4.3. A key feature of this work package is the cooperation of VO expertise with the ESFRI and RI partners in order to support the definition and adoption of common standards for interoperability.

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3. WP4 schedule and resources

The start-up actions have begun immediately following the ESCAPE kick-off meeting in February 2019, and the first 6 months has been used as a ramp-up period for the work package. The contacts for all of the partners have been established and work has begun on all of the tasks.

The calendar of the work package is shown below with all of the Milestones and Deliverables indicated.

CEVO Project schedule table

Month 1	February **2019**	
Month 2	March	
Month 3	April	
Month 4	May	
Month 5	June	**M4.1** Progress and priorities at IVOA
Month 6	July	**D4.1** Detailed project plan for WP4 *(This document)*
Month 7	August	
Month 8	September	
Month 9	October	
Month 10	November	**M4.2** Progress and priorities at IVOA
Month 11	December	
Month 12	January **2020**	
Month 13	February	
Month 14	March	**D4.2** Intermediate report on use of IVOA standards
Month 15	April	
Month 16	May	**D4.3** 1st Science with interoperable data school
Month 17	June	**M4.3** Progress and priorities at IVOA
Month 18	July	**D4.4** Intermediate analysis report of VO data and service integration into EOSC
Month 19	August	
Month 20	September	
Month 21	October	
Month 22	November	**M4.4** Progress and priorities at IVOA
Month 23	December	
Month 24	January **2021**	

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Month 25	February	
Month 26	March	
Month 27	April	
Month 28	May	**M4.5** Hands-on workshop for data providers
Month 29	June	**M4.6** Progress and priorities at IVOA
Month 30	July	**D4.5** Prototype demonstrator for value-added archive services
Month 31	August	
Month 32	September	
Month 33	October	
Month 34	November	**M4.7** Progress and priorities at IVOA
Month 35	December	**D4.6** 2nd Science with interoperable data school
Month 36	January **2022**	
Month 37	February	
Month 38	March	**D4.7** Final analysis report on integration of VO data and services into EOSC
Month 39	April	
Month 40	May	**D4.8** Final analysis report on IVOA standards and stewardship best practices
Month 41	June	
Month 42	July	

Many aspects of the CEVO work plan will depend on the developments that will occur within the EOSC, and also within the IVOA. The time scales for major developments in these bodies are expected to be linked to the schedules of the major meetings. The schedules for the future IVOA Interoperability Meetings, and the events related to EOSC are shown in the tables below:

IVOA Interoperability Meetings during the ESCAPE project.

Location and information about IVOA Interoperability Meetings *[related CEVO Milestone]*	**Dates**
Spring 2019 IVOA Interoperability Meeting *[M4.1]* Paris, France (Hosted by Observatoire de Paris) .	12-19 May 2019
Autumn 2019 IVOA Interoperability Meeting *[M4.2]* Groningen, Netherlands (Following the ADASS 2019 conference).	10-13 Oct 2019
Spring 2020 IVOA Interoperability Meeting *[M4.3]* Sydney, Australia (Hosted by the Australian VO project, ASVO).	*Expected:* May 2020

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Autumn 2020 IVOA Interoperability Meeting *[M4.4]* Granada, Spain (Following the ADASS 2020 conference) – To be confirmed.	*Expected:* Oct/Nov 2020
Spring 2021 IVOA Interoperability Meeting *[M4.6]* Location TBD.	*Expected:* May 2021
Autumn 2021 IVOA Interoperability Meeting *[M4.7]* Location TBD (Expected to be associated with ADASS 2021 conference).	*Expected:* Oct/Nov 2021
Spring 2022 IVOA Interoperability Meeting Location TBD.	*Expected* May 2022

The distribution of the planned effort to be applied to all of the tasks is tabulated below. The initial list of contributing personnel is shown for each partner is shown along with the relevant tasks.

Project	Partner	Name	Task	Planned effort (PM)
VO	CNRS-ObAS	Mark ALLEN	4.1, 4.2, 4.3, 4.4	69
		Francoise GENOVA	4.1, 4.2, 4.4	
		André SCHAAFF	4.1, 4.2, 4.4	
		François BONNAREL	4.2	
		François-Xavier PINEAU	4.3	
		Other permanent staff	4.1, 4.2, 4.3, 4.4	
		Engineer (TBR)	4.1, 4.2, 4.3	
		Scientist (TBR)	4.1, 4.2, 4.3	
KM3NeT	CNRS-CPPM	Paschal Coyle	4.1, 4.2, 4.3	12
		Damien Dornic	4.1, 4.2	
CTA	CTAO	Matthias Fuessling	4.1, 4.2, 4.3	12
		Engineer (TBR)	4.1, 4.2, 4.3	
EGO/Virgo	EGO	Franco Carbognani		12
		Giuseppe Greco	4.2, 4.3	
ELT/ESO	ESO	Martino Romaniello	4.1, 4.2, 4.3	40
		Felix Stoer	4.1, 4.2, 4.3	
		Nima Sedaghat	4.3	
VO	INAF	Marco Molinaro	4.1, 4.2, 4.3	46
		Giuliano Taffoni	4.1, 4.2, 4.3	
		Sara Bertocco	4.1, 4.2, 4.3	

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VO	INTA	Enrique Solano	4.1, 4.2, 4.3	15
		Other INTA staff	4.1, 4.2, 4.3	
JIVE/EVN	JIVE	Arpad Szomoru	4.1, 4.2, 4.3	36
		Engineer (TBR)	4.1, 4.2, 4.3	
EST	KIS	Nazaret Bello Gonzáles	4.1, 4.2, 4.3	12
		Carl Schaffer	4.1, 4.2, 4.3	
		Other KIS staff	4.1, 4.2, 4.3	
SKA/LOFAR	NOW-I-ASTRON	Michiel van Haarlem		12
		Zheng Meyer		
		Other ASTRON staff	4.1, 4.2, 4.3	
CTA/VO	ObsParis	Catherine Boisson	4.1, 4.2, 4.3	14
		Mathieu Servillat	4.1, 4.2, 4.3	
		Contractor (TBR)	4.1, 4.2, 4.3	
EST	ROB	Véronique Delouille	4.1, 4.2, 4.3	24
		Other ROB staff	4.1, 4.2, 4.3	
SKA	SKAO	Rosie Bolton	4.1, 4.2, 4.3	12
		Engineer (TBR)	4.2	
VO	UEDIN	Andy Lawrence	4.1, 4.2, 4.3	14
		Dave Morris	4.1, 4.2, 4.3	
		Stelios Voutsinas	4.1, 4.2, 4.3	
VO	UHEI	Joachim Wambsganns		20
		Markus Demleitner	4.1, 4.2, 4.3	
		Margarida Castro Neves	4.1, 4.2, 4.3	
VO and WP3	*HITS*	*Kai Polsterer*	*4.3*	
		Antonio D'Isanto	*4.3*	

The start-up activities for the work package in the first 12 months of the project involve a number of activities to get the work started, in particular the development of this project plan. The first 6 months has been considered as an administrative ramp-up period during which a number of recruitments have been made at some of the partner institutes. The start-up activities for each task are listed below:

Task 4.1:

- Participation in EOSC-Hub week (April 2019), providing input on the expectation on the EOSC.
- Establishment of contacts with EOSC (Portal, Market Place, EUDAT).
- Continuous collection of input, results and feedback toward the Intermediate analysis report on integration of VO data and services into EOSC" (D4.4).

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Task 4.2:

- Dedicated meetings with ESFRI and RI partners on defining the priorities and first steps as input to the project plan.
- Participation in the May 2019 IVOA Interoperability Meeting (Milestone 4.1. – completed).
- Plan participation in the October 2019 IVOA Interoperability Meeting (Milestone 4.2).
- Preparation for "Science with Interoperable Data" school (D4.3).
- Continuous collection of input, results and feedback toward the "Intermediate analysis report on use of IVOA standards for FAIR ESFRI and community data" (D4.2).
- Recruitment at JIVE partner.

Task 4.3:

- Dedicated series of meetings started for defining the project plan and monitoring the work (February 2019, May 2019, September 2019).
- First steps taken with transfers of data and tests of machine learning classification techniques.
- Recruitment at ESO partner.

Task 4.4:

- Establishment of WP4 in the ESCAPE IT services (calendar, document repository, mailing list, PM monitoring table).
- Preparation of the WP4 Project Plan.
- Cross-WP activities in the start-up period included WP4 participation in workshops organized by WP2 and WP5, and also participation by the WP3 and WP5 leads in events organized by WP4. The cross-WP activities have also been coordinated by the ESCAPE Executive Board meetings.

The Deliverables for the CEVO work package are listed below with their description and type (R-Report, DEM – Demonstrator), and also the lead participant and the due date.

Deliverables (brief description and type)

Number	Description (type)	Task	Lead participant	Month
D4.1	Detailed project plan for WP4 (R)	4.4	CNRS-ObAS	6
D4.2	Intermediate analysis report on use of IVOA standards for FAIR ESFRI and community data (R)	4.2	CNRS-ObAS	14
D4.3	First science with interoperable data school (OTHER)	4.2	INTA	16
D4.4	Intermediate analysis report on integration of VO data and services into EOSC (R)	4.1	INAF	18
D4.5	Release of prototype machine learning enabled archive services providing value-added content to archives (DEM)	4.3	CNRS-ObAS	30

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D4.6	Second science with interoperable data school (OTHER)	4.2	INTA	35
D4.7	Final analysis report on integration of VO data and services into the EOSC (R)	4.1	INAF	38
D4.8	Final analysis report on use of IVOA standards for FAIR ESFRI and community data and best stewardship practices for value-added data (R)	4.2/4.3	CNRS-ObAS	40

4. Risk analysis and management

The risks identified for CEVO at the beginning of the project are tabulated below.

Description of risk (Level)	**Proposed risk-mitigation measures**
EOSC does not meet the needs of the ESFRI. (Low)	Use ESCAPE participation in EOSC to bring requirements and feedback so that developers and users of EOSC can work towards convergence.
Difficulty to align the international IVOA priorities with those arising from ESCAPE. (Medium)	ESCAPE partners have leading roles in the IVOA and Task 4.2 ensures representation of European priorities in IVOA.
EOSC operational framework is delayed (Medium)	Use an incremental adoption plan for use of the EOSC.

Additional risks that have been identified in the first 6-month ramp-up period of the project are mostly related to practical issues of recruitment by the partners for various aspects of the CEVO tasks.

Description of risk (Level)	**Proposed risk-mitigation measures**
Difficulty to find suitable contract staff (Medium)	Advertisements for contractual positions are to be distributed as widely as possible using the channels of the ESCAPE project.
Hired contract staff depart prematurely (Medium)	The partners will manage their contract personnel and indicate any risks if they arise.

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