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ESCAPE MILESTONE 23 – PROGRESS AND PRIORITIES AT IVOA (4)

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Lead Author (Org)	Mark Allen (CNRS-ObAS)
Contributing Author(s) (Org)	Hendrik Heinl (CNRS-ObAS)
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Table of Contents

Table of Contents ***3***

1. Introduction: IVOA Interoperability Meeting **4**

2. ESCAPE CEVO and European participation **4**

3. Selected highlights from IVOA Working- and Interest-Groups relevant to ESCAPE CEVO **5**

4. Conclusions and next steps **9**

Appendix A. – Presentations **10**

1. Introduction: IVOA Interoperability Meeting

The International Virtual Observatory Alliance (IVOA) Interoperability Meeting was originally planned to be held in Granada, Spain 13-15 November 2020 following the ADASS XXX conference[1]. Due to the COVID-19 virus global pandemic, the ADASS conference was converted into an on-line event November 8-12, 2020. Following this change, the IVOA Interoperability Meeting was re-scheduled as an on-line event which was held on 17-19 November 2020. This second on-line meeting was organised using a similar approach to the first one (MS22), with the sessions being arranged to accommodate a wide participation of projects and individuals from around the globe. The meeting included 16 sessions (spread over 6-23h UTC) during the 3-day meeting.

This Interoperability Meeting was a formal milestone for the ESCAPE CEVO Work Package (ESCAPE Milestone 23 – Progress and priorities at IVOA(4)). The priorities of the ESCAPE partners have continued to be well represented at IVOA, as is demonstrated by the many contributions and interactions of CEVO partners in the meeting. It should also be noted that CEVO activities for this event have been strongly coordinated with the CEVO participation in the ADASS XXX conference where many ESCAPE results have been presented, as highlighted in a recent ESCAPE news item and submitted for publication in the ADASS XXX proceedings[2].

In this report we outline the progress of the CEVO Work Package activities that have been presented at the IVOA meeting, and we track the participation of ESCAPE partners (and also the wider European contributions) in IVOA. The means of verification for these milestones are the IVOA meeting website and the record of ESCAPE participation in the meeting.

This Interoperability Meeting gathered 213 participants for the 3-day meeting. This is the highest ever attendance of an IVOA meeting, continuing the trend of very high participation in virtual events (which are made more accessible by being on-line and avoiding travel costs). The web pages, including the detailed schedule of the meeting and the list of participants are available at the links in the table below.

Meeting Page (hosted via INAF)	https://indico.ict.inaf.it/event/1155/
Detailed IVOA Schedule Page	https://wiki.ivoa.net/twiki/bin/view/IVOA/InterOpNov2020
Social Media	#ivoa20virtual, *Twitter :* https://twitter.com/IVOAastro

2. ESCAPE CEVO and European participation

There was a high level of European participation in this meeting. The list of contributions with a link to the slides presented, is tabulated in Appendix A of this report, with the ESCAPE CEVO contributions indicated.

[1] https://adass2020.es
[2] https://projectescape.eu/events/adass-xxx-conference , arXiv article: https://arxiv.org/abs/2012.11534

ESCAPE CEVO partners have also contributed to the planning of the meeting in the IVOA Executive Committee and the IVOA Technical Coordination Group (TCG). As for the first on-line interoperability meeting, the ESCAPE INAF/OATS partner provided the registration and meeting planning pages in support of this international meeting, and overall ESCAPE was highly visible in the meeting.

3. Selected highlights from IVOA Working- and Interest-Groups relevant to ESCAPE CEVO

Data Model Working Group sessions

The Provenance Data Model is identified as a high priority for ESCAPE CEVO partners (in particular CTA and KM3NeT related partners). This subject has reached a level of maturity where i.) the IVOA standard was approved[3] in April 2020, ii.) a dedicated ESCAPE CEVO workshop[4] was held in September 2020., and iii.) ESCAPE CEVO partners led a community "BoF" discussion session during the ADASS XXX conference. The results and feedback of the workshop were brought to the international level at this interoperability meeting by M. Servillat (Obs Paris) in a presentation on "Provenance activities in the European project ESCAPE". The focus of these activities is now on implementation and feedback from implementations. Other Data model topics addressed by ESCAPE CEVO partners concerned standards for time series data and radio astronomy "visibilities" data, specifically as a proposed extension to the ObsCORE DM standard.

Radio Astronomy Interest Group Session

The Radio Astronomy IG was established in 2020 and is actively working on requirements for the representation of radio astronomy data in the VO (see the IVOA Radio Astronomy IG wiki pages[5])
F. Bonnarel (CNRS-ObAS) as the Vice-Chair has brought the ESCAPE CEVO partner priorities to this group, and the session at this interop meeting included a detailed status report on the VO standards necessary for radio astronomy. F. Bonnarel led a discussion on "(Enhancing description of radio data in VO standards" which outline the ways of publishing radio data using existing VO standards, and highlighted the issues of the limits, caveats and possible extensions to the standards following the demands of radio astronomy community. Practical implementations by CEVO partners ASTRON and JIVE have been shown in the presentations "JIVE – VO interface prototype for the EVN archive" by M. Kettenis, and "The Apertif DR1" by Y. Grange.

Grid & Web Services Interest Group Sessions

The GWS-WG session focused on Authentication & Authorization. The report on implementation by M. Taylor (Univ. Bristol) shows how VO services like TAP services, and also VO applications like TOPCAT may implement authentication. We identify this as being relevant for the interoperability of AAI across platforms, services and tools and we flag it as a future point for discussion in ESCAPE across the different work packages.

[3] https://www.ivoa.net/documents/ProvenanceDM/20200411/index.html
[4] https://indico.in2p3.fr/event/21913/
[5] https://wiki.ivoa.net/twiki/bin/view/IVOA/IvoaRadio

Data Access Layer Working Group Sessions

The three DAL WG sessions covered a range of topics relevant to ESCAPE, in particular there were several discussions on the status and updates of existing standards (Datalink, ADQL, SODA, SIAv2, SCS) as well as reports on the recently introduced standard ObjVisSAP (relevant to planning of multi-messenger observing, including EM follow-up of GW events). A working draft on the EPN-TAP showed the progress on the specific demands of the planetary and solar astronomers community (relevant to EST related data). The status of the Datalink standard is of particular importance as it is in heavy use in the ESO archive services. The evolution of the SIA2 and SODA standards as presented by F. Bonnarel (CNRS-ObAS). Other ESCAPE contributions were for standardisation of the way spectral line data may be queried with TAP services in "LineTAP: a proposal for an IVOA relational model for spectral lines" by M. Castro-Neves (UHEI) in collaboration with the VAMDC consortium[6], IRAP[7], and PADC[8].

Operations Interest Group Session

The Operations IG coordinates and publicizes the activities of individuals, institutions and groups interested in facilitating robust operations of distributed astronomy applications, particularly those based upon implementations of IVOA protocols. The sessions at this meeting included the discussion of topics that are very relevant to the operational stability and sustainability of the VO framework in Europe, which will be important for the various levels of potential integration of VO services with EOSC. In particular the operational validation of resources in VO registries, and the growth of the HiPS network for access to large sky survey data sets.

The European Virtual Observatory registry[9] is operated by the ESAC Science Data Centre, and they monitor the compliance of the resources using a set of validators for the IVOA protocols. The report presented by C. Arviset (ESA) on "Euro-VO Resources Validation Status" showed the results for the validation of services that use the Simple Cone Search (SCS v1.03), Simple Image Access (SIA v1.0), Simple Spectra Access (SSA v1.1) anf the Table Access Protocol (TAP v1.0 and v1.1). The validation results are overall good, but can vary from one standard to another. Analysis of the results shows that in some cases there are improvements that are necessary in the standard, and that in some cases services need to improve their level of compliance. In terms of relevance to ESCAPE partners it is important to raise the awareness of the available validators so that they may check the compliance of services during the development phase. The topic is flagged for discussion at the 2021 CEVO event "Hands-on Workshop for Data Providers" (MS24).

Another very relevant discussion for ESCAPE partners was the review of the HiPS standard which has now been in place for more than 3 years. P. Fernique (ObAS) presented the review with the aid of a demonstration (using the ESCAPE supported improvement of Aladin Lite) by M. Baumann (CNRS-ObAS). The HiPS network is the fastest growing component of the VO framework, which is attributed to the ease of generating HiPS data sets for large surveys, the ease of implementation, and the client

[6] http://www.vamdc.org
[7] https://www.irap.omp.eu/en/homepage-en/
[8] https://padc.obspm.fr
[9] http://registry.euro-vo.org

tools and services available for their use (e.g. ADASS XXX poster[10] by T. Boch (ObAS)). The review identified the different successes and challenges. For ESCAPE partners we highlight the flexibility of the system and its importance for the science portals of ESO, and other services that publish or are working toward publishing HiPS (e.g. radio astronomy surveys, and also LSST[11] etc.). As above, this topic is flagged for discussion at the 2021 CEVO event "Hands-on Workshop for Data Providers" (MS24). The ESCAPE CEVO progress on the improvements to the Aladin Lite HiPS viewer have been presented during the ADASS XXX conference by M. Baumann (CNRS-ObAS) with the presentation and video available[12] on the conference web pages.

Registry / Semantics Working Group Session

The combined Registry and Semantics session focused on discussions on how to upgrade large publishing registries ("Upgrading the largest VO publishing registry", S. Derriere (ObAS)), and also on the use of standardized vocabularies in implementations and applications ("Vocabularies n the VO: Implementations and Applications", M. Demleitner (UHEI)). The registry upgrade topics are important for the general topic of how resources are published, and how their metadata are managed in a sustainable way. As such the information from discussion is taken as input for Task 4.1 of CEVO, and it will be of interest to bring this astronomy experience to the wider EOSC discussions via the CEVO connections with EOSC projects.

Applications Working Group Session

The Applications WG sessions covered a number of aspects of science applications that use VO standards. This is of particular importance for ESCAPE CEVO partners for the activities that connect the science users with the tools and services that provide the data and science functions. The highlights of the session with respect to the ESCAPE priorities were the discussions on the SAMP interoperability protocol which enables applications to work together, and also the discussion on the future of the MOC 2.0 standard for describing sky coverage.

The presentation on "Web SAMP + HTTPS" by M. Taylor (Bristol) showed the progress on using this protocol with HTTPS services, reporting that a number of important challenges have been overcome and that many web browsers can now support this functionality. This is good news as many of the applications planned for use in CEVO schools (D4.3, D4.6) use this protocol for interoperability. It will however be important to document which web browsers this applies to, and include it in the training materials which is taken as an action in Task 4.2 of CEVO.

The Multi-Order Coverage map standards v2.0 was discussed (led by P. Fernique (ObAS) with CEVO input and other international partners). MOC v2.0 is a generalization of the MOC concept which extends it to a system which can charactarize the coverage of space (i.e. a region on the sky) with coverage on a temporal axis (time). The evolution from v1.1 to v2.0 is thus a major upgrade, which

[10] https://adass2020.es/static/ftp/P9-170/P9-170.pdf
[11] E.g. https://project.lsst.org/reviews/lsp-fdr/sites/lsst.org.reviews.lsp-fdr/files/LSP-FuncArch-20190410-v1.pdf
[12] https://schedule.adass2020.es/adass2020/talk/BGV8W9/

takes into account requirements that have been gathered from ESCAPE partners. In particular, this work has directly brought the expectations from the Gravitational Wave community into IVOA via the interaction of the CEVO EGO-Virgo partner (G. Greco, Univ. Urbino). The early results of this work have been presented[13] at the ADASS XXX conference. Other related topics presented by ESCAPE partner (M. Demleitner, UHEI) concerned the use of MOC with the postgres extension called pgSphere.

[13] https://schedule.adass2020.es/adass2020/talk/WUBSFS/

4. Conclusions and next steps

The IVOA interoperability meeting was a successful milestone for CEVO. This second *virtual* IVOA Interoperability meeting proved to be a productive event with many participants, and since it was the shorter of the two annual interoperability meetings it was more focused on specific topics (e.g. radio astronomy and data provenance). The ESCAPE project was very visible, with 9 CEVO-led contributions. This interoperability meeting followed ADASS XXX, and the presentation of many ESCAPE results was made at ADASS XXX, and the interoperability meeting served as a working meeting more dedicated to discussion and advancing on IVOA standards.

This Milestone has been achieved in the same month as the mid-term review of the ESCAPE project, and it also follows the major CEVO deliverable reports for Tasks 4.1 and 4.2 that have been made in the first half of the project, namely the "Intermediate Analysis Report on Use of IVOA Standards for FAIR ESFRI and Community Data" D4.2[14], and "Intermediate analysis report of VO data and service integration into EOSC" D4.4[15], as well of course as the mid-term review report. The year 2020 has been challenging due to the difficulty of not having in-person meetings, and it has been necessary to adapt the way of working by having virtual meetings and events. This is expected to continue into at least the first half of 2021. The CEVO Work Plan continues to provide the path for the next steps, but will also be adapted based on the results of the mid-term review and also on the needs of the project. The next steps in the plan include a number of training events targeted at scientific users, the "1st Science with Interoperable Data School", D4.3 in February 2021, and also targeted at the community of data providers in the "Hands-one event for Data Providers" MS24 being planned for June 2021. The next steps in terms of the IVOA related Milestones (MS25, MS26) are expected to go ahead as planned in May 2021 and October/November 2021. The May 2021 IVOA interoperability meeting will be another on-line meeting but with a 5-day format. Being the major interoperability meeting for 2021 it is important for WP4 to prepare and coordinate its participation. This will be done via an on-line Technology Forum which is expected to be held earlier in 2021. As with the first Technology Forum[16], we will plan for this to be a major WP4 meeting that checks progress and prepares for the next year of the project. The status of the various developments and implementations at the ESFRI-related partners will be reviewed.

We expect that the next phase of the project will involve even more cross-WP activities, in particular with the use of VO-enabled services in the WP5 platform, and testing of the data lake implementations for data that has been retrieved from VO services. Close interaction will continue with WP3 on open source software, and also on the metadata descriptions of services (in the context of EOSC). Also, the use of VO-enabled services will be developed as part of the test science projects being prepared at the project level.

[14]https://cloud.projectescape.eu/index.php/apps/onlyoffice/2617?filePath=%2FCEVO%2FDeliverables%2FD4.2%2FESCAPE_D4.2_v1.0.pdf
[15] https://projectescape.eu/deliverables-and-reports/d44-intermediate-analysis-report-integration-vo-data-and-services-eosc
[16] https://indico.in2p3.fr/event/20005/

Appendix A. – Presentations

The table below contains a list of all the contributions at the IVOA interoperability meeting that are relevant to CEVO. Presentations made by members of CEVO partner institutes are indicated, and we also identify the European contributions. A link to the presentations files on the IVOA interoperability meeting web pages are provided for each contribution. Additionally a repository of the presentations has been created with the original presentation files (with the filenames prefixed with the presentation number in the table).

Opening plenary sessions	
01. Opening Plenary Presentation: State of the IVOA Link to presentation	C. Cui *(NAOC)* *(input from ESCAPE-CEVO)*
02. Committee for Science Priorities Status Link to presentation	B. Merin (ESA) and CSP [incl. M. Allen (CNRS-ObAS) - *ESCAPE-CEVO*]
Data Access Layer sessions	
03. ObjVisSAP status & discussion Link to presentation	A. Ibarra (*ESA*) (*European Contribution*)
04. Applications of Vocabularies 2 Link to presentation	M. Demleitner (*UHEI*) (*ESCAPE-CEVO*)
05. EPN-TAP Working Draft Link to presentation	S. Erard (*Obs-Paris*) (*European Contribution – Europlanet project*) *– relevant to use of EPN-TAP by ESCAPE EST partners for solar data.*
06. LineTAP: a proposal for an IVOA relational model for spectral lines Link to presentation	M. Castro-Neves (*UHEI*) (*ESCAPE-CEVO*)
07. Datalink status report & discussion Link to presentation	F. Bonnarel (CNRS-ObAS) *(ESCAPE-CEVO)*
08. ADQL-2.1 status Link to presentation	G. Mantelet (CDS) *(European Contribution)*
09. SIA2 and SODA evolution status Link to presentation	F. Bonnarel (CNRS-ObAS) *(ESCAPE-CEVO)*
Radioastronomy Interest Group session	

10. Enhancing description of radio data in VO standards Link to presentation	F. Bonnarel (CNRS-ObAS) *(ESCAPE-CEVO)*
11. The Apertif DR1 Link to presentation	Y. Grange (ASTRON) *(European Contribution)*
12. JIVE – VO interface prototype for the EVN archive Link to presentation	M. Kettenis (ASTRON) *(ESCAPE-CEVO)*
Operations Interest Group sessions	
13. HiPS Network 3 years after the REC Link to presentation	P. Fernique (CDS), M. Baumann (CNRS-ObAS) *(ESCAPE-CEVO, European contribution – ESCAPE demo of Aladin Lite v3)*
14. Euro-VO Resources Validation Status Link to presentation	C. Arviset (ESA) *(European Contribution)*
Grid & Web Services sessions	
15. Single Sign On and Group Authorization Introduction Link to presentation	S. Bertocco (INAF-OATS)
16. Authentication Implementation Report Link to presentation	M. Taylor (Bristol) *(European contribution)*
17. An OAuth2-based GMS implementation – update Link to presentation	S. Zorba & IA2 team (INAF) *(European contribution)*
Registry / Semantics Work Group sessions	
18. Upgrading the largest VO publishing registry Link to presentation	S. Derriere, G. Landais, A. Guyot (CDS) *(European contribution)*
19. Vocabularies 2 and the Registry Link to presentation	M. Demleitner (UHEI) *(European contribution)*
Applications Working Group sessions	
20. Web SAMP +HTTPS update Link to presentation	M. Taylor (Bristol) *(European contribution)*

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	(relevant to interoperability of tools, and platforms)
21. MOC 2.0 Status and Discussion Link to presentation	P. Fernique (CDS) *(European contribution. ESCAPE-CEVO)*
Data Model Working Group sessions	
22. Provenance activities in the European project ESCAPE Link to presentation	M. Servillat (Obs Paris) *(ESCAPE-CEVO)*
23. ProvTAP evolution after first community feedback Link to presentation	F. Bonnarel (CNRS-ObAS) *(ESCAPE-CEVO)*
24. ObsCORE DM Proposed Extension for time series and radio visibilities Link to presentation	M. Louys (iCUBE), F. Bonnarel, A. Nebot, L. Michel (CNRS-ObAS) *(ESCAPE-CEVO +)*
25. ObsLocTAP Status Link to presentation	J. Salgado (ESA) *(European contribution)* *(Relevant to multi-messenger EM follow-up interests of ESCAPE)*
26. MANGO - A Model for Source Data Model & VOTable Mapping Link to presentation	L. Michel (ObAS), F. Bonnarel (CNRS-ObAS), G. Landais (ObAS), M. Louys (iCube), M. Molinaro (INAF-OATS), J. Salgado (ESA) *(ESCAPE-CEVO + European Contribution)*

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