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Third ASTERICS DADI Technology Forum

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Abstract

The Third ASTERICS DADI Technology Forum was held in Strasbourg, 22-23 March 2017. The goals of the forum were to share information between project members and to prepare for the May 2017 IVOA Interoperability Meeting. The forum began with a review of ASTERICS DADI and of the status of the IVOA and was followed by sessions with contributed presentations. The detailed discussions and the hack-a-thon sessions fulfilled the role of the forum as a working meeting. This well attended forum at the mid-point of the ASTERICS project showed that the partners are working efficiently with significant results in priority areas, and well defined plans for the second half of the project. The forum also allowed the consolidation of important European input to the following IVOA meeting.

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II. DELIVERY SLIP

	Name	Partner / WP	Date
From	M. Allen	CNRS/CDS/WP4	22 July 2017
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Reviewed by	R. van der Meer	ASTRON/WP1	27 July 2017
Approved by	AMST		31 July 2017

III. DOCUMENT LOG

Issue	Date	Comment	Author/Partner
1	08 July 2017	Advanced draft sent for comments to WP4	M. Allen, CNRS/CDS
2	11 July 2017	Feedback on the advanced draft	F. Genova, CNRS/CDS
3	22 July 2017	Draft sent to the Project Manager and Project Scientist	M. Allen, CNRS/CDS

IV. APPLICATON AREA

This document is a formal deliverable for the GA of the project, applicable to all members of the ASTERICS project, beneficiaries and third parties, as well as its collaborating projects.

V. TERMINOLOGY

A&A: Authorisation and Authentication

ADASS: Astronomical Data Analysis Software & Systems conference series

AIDA: Astronomical Infrastructure for Data Access

Aladin: Sky atlas and discovery tool

ANTARES: Astronomy with a Neutrino Telescope and Abyss environmental RESearch

APC: AstroParticule et Cosmologie

ASTERICS: Astronomy ESFRI & Research Infrastructure Cluster

ASTRON: Netherlands Institute for Radio Astronomy

CANFAR: Canadian Advanced Network for Astronomical Research

CDS: Centre de Données astronomiques de Strasbourg

CLEOPATRA: Connecting Locations of ESFRI Observatories and Partners in Astronomy for Timing and Real-time Alerts

CNRS: Centre National de la Recherche Scientifique

CoRoT: COnvection ROtation and planetary Transits

CoSADIE: Collaborative and Sustainable Astronomical Data Infrastructure for Europe

CSP: IVOA Committee for Science Priorities

CTA: Cherenkov Telescope Array

DADI: Data Access, Discovery and Interoperability

DAL: Data Access Layer

DALI: Data Access Layer Interface

Datalink: means of connecting one location to another for the purpose of transmitting and receiving digital information

Docker: a software container platform

ELT: Extremely Large Telescope (was E-ELT)

EGO: European Gravitational Observatory

ERA-NET: European Research Area Network

ESFRI: European Strategy Forum on Research Infrastructures

ESO: European Organisation for Astronomical Research in the Southern Hemisphere

Euro-VO: European Virtual Observatory

GAVO: German Astrophysical Virtual Observatory

HEALPix: Hierarchical Equal Area isoLatitude Pixelization

HiPS: Hierarchical Progressive Survey

ICE: International Cooperation Empowerment

JSON: JavaScript Object Notation

INAF: Istituto Nazionale di Astrofisica

INTA: Instituto Nacional de Técnica Aeroespacial

IVOA: International Virtual Observatory Alliance

KM3NeT: A multi-km3 sized Neutrino Telescope

LSST: Large Synoptic Survey Telescope

LUTH: Laboratoire de l'Univers et de ses Théories

MOC: Multi-Order Coverage

OAS: Observatoire Astronomique de Strasbourg

ObsCore: Observational Core Data Model

PDL: Parameter Description Language

PQL: Parameter Query Language

RDA: Research Data Alliance

RegTAP: An IVOA Recommendation for use of IVOA Registries with TAP

RFC: Request For Comments

SED: Spectral Energy Distribution

SIA: Simple Image Access

SIMBAD: Set of Identifications, Measurements and Bibliography for Astronomical Data

SimDAL: Simulation Data Model

SKA: Square Kilometre Array

SME: Small Medium Enterprise

SODA: Server-side Operations for Data Access

Spark: a cluster computing platform

SSAP: Simple Spectral Access Protocol

SSO: Single Sign On

SVOM: Space-based multiband astronomical Variable Objects Monitor - Chinese-French space mission

STILTS: Starlink Tables Infrastructure Library Toolset

TAP: Table Access Protocol

TOPCAT: Tool for Operations on Catalogues and Tables

UEDIN: University of Edinburgh

UHEI: Ruprecht-Karls-Universität Heidelberg

UNISTRA: Université de Strasbourg

UWS: Universal Worker Service

VAMDC: Virtual Atomic and Molecular Data Centre

VIRGO: Interferometer for detection of Gravitational Waves

VizieR: Database of astronomical catalogues, published tables and other data

VO: Virtual Observatory

VOSA: Virtual Observatory SED Analyzer

VTP: VOEvent Transfer Protocol

WP: Work package

A complete project glossary is provided at the following page:
http://www.asterics2020.eu/glossary/

VI. PROJECT SUMMARY

ASTERICS (Astronomy ESFRI & Research Infrastructure Cluster) aims to address the cross-cutting synergies and common challenges shared by the various Astronomy ESFRI facilities (SKA, CTA, KM3NeT & ELT). It brings together for the first time, the astronomy, astrophysics and particle astrophysics communities, in addition to other related research infrastructures.

The major objectives of ASTERICS are to support and accelerate the implementation of the ESFRI telescopes, to enhance their performance beyond the current state-of-the-art, and to see them interoperate as an integrated, multi-wavelength and multi-messenger facility. An important focal point is the management, processing and scientific exploitation of the huge datasets the ESFRI facilities will generate. ASTERICS will seek solutions to these problems outside of the traditional channels by directly engaging and collaborating with industry and specialised SMEs. The various ESFRI pathfinders and precursors will present the perfect proving ground for new methodologies and prototype systems.

In addition, ASTERICS will enable astronomers from across the member states to have broad access to the reduced data products of the ESFRI telescopes via a seamless interface to the Virtual Observatory framework. This will massively increase the scientific impact of the telescopes, and greatly encourage use (and re-use) of the data in new and novel ways, typically not foreseen in the original proposals. By demonstrating cross-facility synchronicity, and by harmonising various policy aspects, ASTERICS will realise a distributed and interoperable approach that ushers in a new multi-messenger era for astronomy.

Through an active dissemination programme, including direct engagement with all relevant stakeholders, and via the development of citizen scientist mass participation experiments, ASTERICS has the ambition to be a flagship for the scientific, industrial and societal impact ESFRI projects can deliver.

VII. EXECUTIVE SUMMARY

The Third ASTERICS DADI Technology Forum was a well attended and highly productive event. It built on the work of the First and Second Technology Forums with a strong emphasis on technology and collaboration. The meeting was organised with the well established structure of formal presentations followed by informal working 'Hack-a-thon' discussions, which was effective for exchange of information and leading the project into the next steps.

The objectives of the meeting were fulfilled with excellent progress on the aims expressed in the First Technology Forum and continued in the Second Technology Forum. This event, at the mid-term point of the ASTERICS project shows the DADI work is fully on track with significant results being reported. Important progress has been made on the initial DADI priority areas of multi-dimensional data and time domain astronomy. The priority topic of multi-dimensional data has reached a milestone with the first set of standards being established by the IVOA, with key input from the DADI teams. The Technology Forum provided important coordination of the recent intense efforts in the time domain priority area.

An assessment of the relevance of the Technology Forums for preparation of ASTERICS DADI input to the IVOA has been done, and this demonstrates the high impact of DADI at IVOA and the effectiveness of the Technology Forums.

The Fourth Technology Forum is planned to be held in March 2018 in Edinburgh and a Fifth Technology forum is planned for early 2019 in Strasbourg.

Table of Contents

I. COPYRIGHT NOTICE 1
II. DELIVERY SLIP 2
III. DOCUMENT LOG 2
IV. APPLICATON AREA 2
V. TERMINOLOGY 3
VI. PROJECT SUMMARY 6
VII. EXECUTIVE SUMMARY 7
Table of Contents 8
1. Introduction 8
2. Participants 11
3. Programme 14
4. Proceedings and Analysis 17
5. Next Steps 27
6. Assessment of the relevance of the Technology forum with respect to the IVOA Shanghai Interoperability Meeting 28
7. Conclusions 29

1. Introduction

The European Virtual Observatory initiative began to organise regular “Technology Forums” during the VO-TECH Design Study (2005-2009). VO-TECH was led by the University of Edinburgh (UEDIN). These meetings gathered the European teams involved in the development of the VO framework of standards and tools to disseminate information about technological activities and expertise, to build collaborations, to discuss future activities and to coordinate European participation in bi-yearly International Virtual Observatory Alliance (IVOA) “Interoperability” meetings. The astronomical Virtual Observatory is an international endeavour, and the IVOA leads the development of the interoperability standards, in which European teams have been playing a key role since the beginning.

The usefulness of these meetings was immediately obvious, and they were continued by all of the follow-up projects funded by the European Commission in the e-Infrastructure framework during FP7: the Integrated Infrastructure Initiative Euro-VO Astronomical

Infrastructure for Data Access (EuroVO-AIDA, 2008-2010), as well as the two small Coordination Actions on which the coordination of European VO activities relied from 2010 to 2015: Euro-VO International Coordination Empowerment (EuroVO-ICE, 2010-2012) and Collaborative and Sustainable Astronomical Data Infrastructure for Europe (CoSADIE, 2012-2015).

Coordination of technological activities has been identified as one of the three pillars of the European Virtual Observatory[1], together with the support given to data providers to publish their data in the VO, and to astronomers in their usage of the VO. It was clear, when the *Data Access, Discovery and Interoperability* Work Package was set up for the ASTERICS proposal, that regular gatherings of the technical teams would be necessary. In addition to continuing the coordination of the technical work on VO development in Europe, Technology Forums were also identified as a key vehicle to put in touch the technical teams working on the VO and those from the ESFRI and pathfinder teams, to share knowledge and build collaborations on technical work. The Forums are thus part of ASTERICS WP4 Task 4.3 "Update of the VO framework from feedback and requirements", co-led by UEDIN and CNRS/UMR7550-CDS.

1	ASTERICS DADI Technology Forum 1	Strasbourg, 17 & 18 September 2015
2	ESFRI Forum and Training Event 1	Trieste, 3 & 4 December 2015
3	ASTERICS DADI School 1	Madrid, 15-17 December 2015
4	ASTERICS DADI Technology Forum 2	Edinburgh, 7 & 8 March 2016
5	European Data Provider Forum Training Event 1	Heidelberg, 15 & 16 June 2016
6	ASTERICS DADI School 2	Strasbourg, 15-17 November 2016
7	ASTERICS DADI Technology Forum 3	Strasbourg, 22-23 March 2017

Table 1 : ASTERICS DADI Events (Deliverables)

[1] Genova,F., Allen, M.G., Arviset, C., Lawrence, A., Pasian, F., Solano, E., Wambsganss, J. : Euro-VO – Coordination of virtual observatory activities in Europe, Astronomy & Computing, Vol. 11, pp. 181-189, 2015, ArXiv 1506.06567

ASTERICS Deliverable 4.7 “Third ASTERICS DADI Technology Forum”, organised by CNRS/UMR7550-CDS in Strasbourg on 22-23 March 2017, was the seventh event organised by ASTERICS WP4 following the series of events shown in Table 1.

In addition to the events above DADI has also held a number of special events that have been organised in response to specific needs identified by the partners. These events are listed in Table 2 below. In addition a cross-work-package (WP3 and WP4) discussion was held on the topic of Authentication and Authorisation.

Participation in the meeting is described in Section 2 of this document. The meeting programme was organised to disseminate relevant information, in addition to technical discussions. This programme is presented in Section 3, and a record of the event is provided on the Wiki at:

https://www.asterics2020.eu/dokuwiki/doku.php?id=open:wp4:wp4techforum3

The proceedings and results are analysed in Section 4. The next steps are given in Section 5, followed by an assessment of the relevance of the Forum with respect to IVOA in Section 6, and conclusions in Section 7.

1	DADI-Gravitational Wave community meeting	Strasbourg, 31 May-1 June 2016
2	DADI-LOFAR meeting – publication of visibility data in the VO	Strasbourg, 18 Nov 2016
3	“Provenance Days” – Leading the preparation of the IVOA Provenance Data Model	Montpellier, 3-4 May 2017 Strasbourg, 13 December 2016 Paris, 20 July 2016 Heidelberg, 14 June 2016 Paris, 14 April 2016 Paris, 6-7 July 2015
4	DADI-CLEOPATRA Time Domain Meeting	Strasbourg, 21 March 2017

Table 2 : ASTERICS DADI Special Events relevant to Technology Forum 3

2. Participants

45 participants attended the meeting making it the most highly attended Technology Forum so far in the ASTERICS project. There were representatives from all but one of the WP4 partners, i.e. representatives from ASTRON (LOFAR), CNRS/CDS, CNRS/LUTH (CTA), CNRS/APC (VIRGO/EGO), INAF, INTA, UEDIN and UHEI. KM3NeT was not present at the meeting, but was represented at the special event that occurred on the day before.

ESO, an associate partner of ASTERICS, and in particular of WP4 for the ELT, was represented at the meeting. ESA, which continues as a strong contributor to Euro-VO, was also represented at the meeting. Members from VAMDC were invited to the meeting via the CNRS/LUTH partner.

The participants came from all of the ASTERICS DADI partner countries, and a representative from the Czech Republic was invited to the meeting on a specific topic. The distribution of participants from different countries, and international organisations (ESO and ESA) is shown in the pie chart below. This indicates a strong participation from France, the hosting country for this meeting with 24 participants (including 15 from the host organisation, CDS).

The professional profiles of the participants includes a healthy mixture of scientists and software engineers working on VO, and also ESFRI/pathfinder teams.

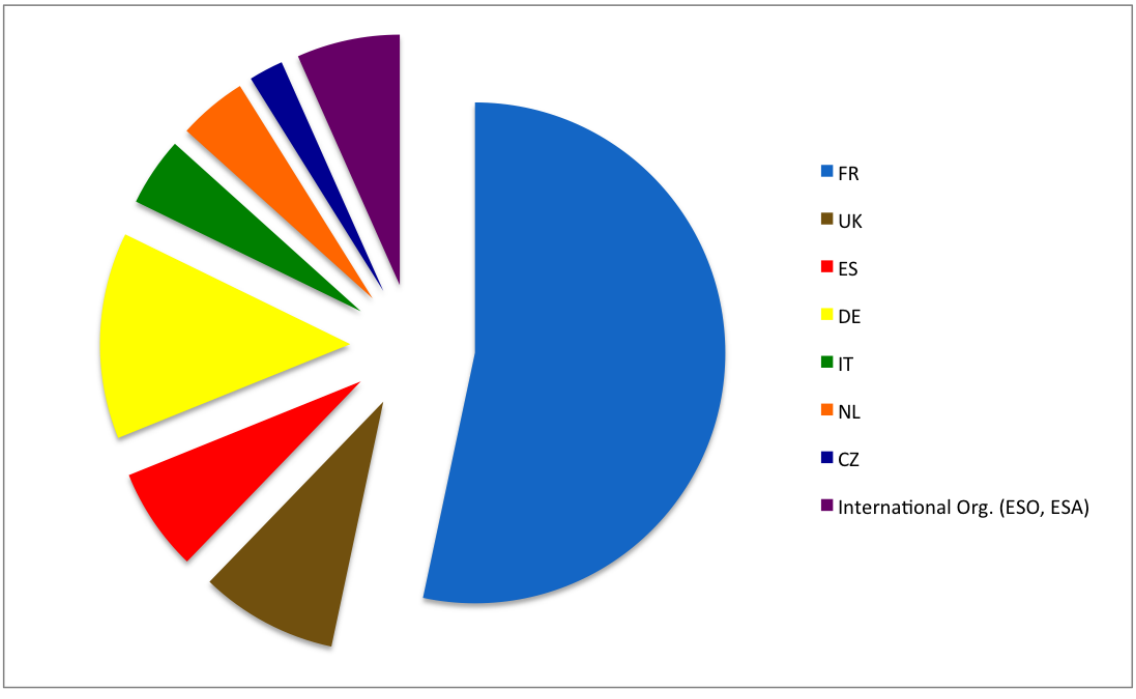
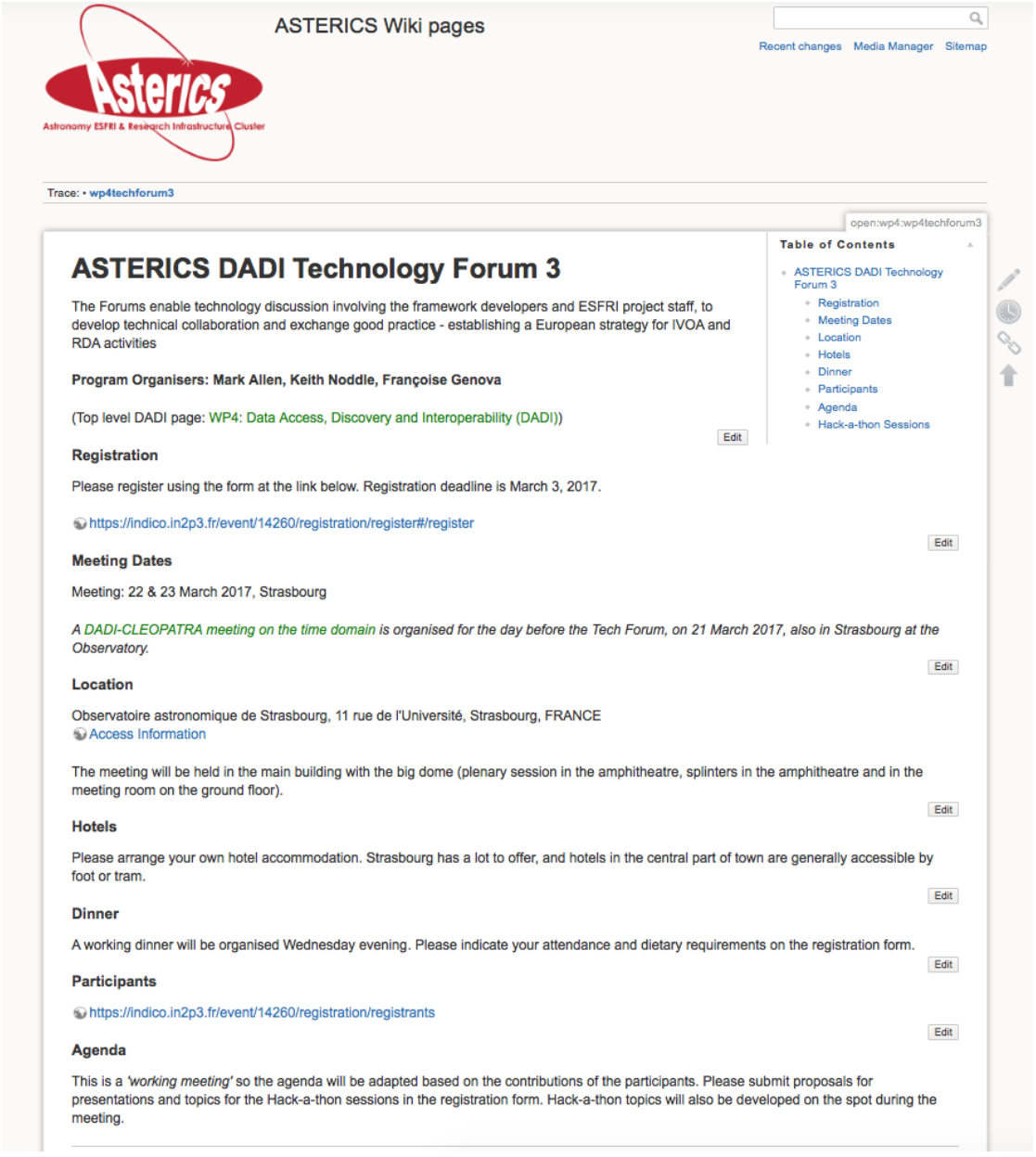


Figure 1 : Participant countries of origin

The meeting was advertised within the project, and the associated partners were also informed. In addition to the ASTERICS wiki, an INDICO system was also used to organize the meeting (following the positive experience of the previous VO School), in particular for managing the registration of participants and collection of contributions for the schedule.

The main wiki page for the meeting, and also the top level INDICO registration pages are shown in figures below.



ASTERICS Wiki pages

Recent changes Media Manager Sitemap

Trace: • wp4techforum3

open:wp4:wp4techforum3

ASTERICS DADI Technology Forum 3

The Forums enable technology discussion involving the framework developers and ESFRI project staff, to develop technical collaboration and exchange good practice - establishing a European strategy for IVOA and RDA activities

Program Organisers: Mark Allen, Keith Noddle, Françoise Genova

(Top level DADI page: WP4: Data Access, Discovery and Interoperability (DADI))

Edit

Registration

Please register using the form at the link below. Registration deadline is March 3, 2017.

https://indico.in2p3.fr/event/14260/registration/register#/register

Edit

Meeting Dates

Meeting: 22 & 23 March 2017, Strasbourg

A DADI-CLEOPATRA meeting on the time domain is organised for the day before the Tech Forum, on 21 March 2017, also in Strasbourg at the Observatory.

Edit

Location

Observatoire astronomique de Strasbourg, 11 rue de l'Université, Strasbourg, FRANCE
Access Information

The meeting will be held in the main building with the big dome (plenary session in the amphitheatre, splinters in the amphitheatre and in the meeting room on the ground floor).

Edit

Hotels

Please arrange your own hotel accommodation. Strasbourg has a lot to offer, and hotels in the central part of town are generally accessible by foot or tram.

Edit

Dinner

A working dinner will be organised Wednesday evening. Please indicate your attendance and dietary requirements on the registration form.

Edit

Participants

https://indico.in2p3.fr/event/14260/registration/registrants

Edit

Agenda

This is a *'working meeting'* so the agenda will be adapted based on the contributions of the participants. Please submit proposals for presentations and topics for the Hack-a-thon sessions in the registration form. Hack-a-thon topics will also be developed on the spot during the meeting.

Table of Contents

- ASTERICS DADI Technology Forum 3
  - Registration
  - Meeting Dates
  - Location
  - Hotels
  - Dinner
  - Participants
  - Agenda
  - Hack-a-thon Sessions

Figure 2 : ASTERICS wiki page for the meeting (Wiki address as in section 1: https://www.asterics2020.eu/dokuwiki/doku.php?id=open:wp4:wp4techforum3)

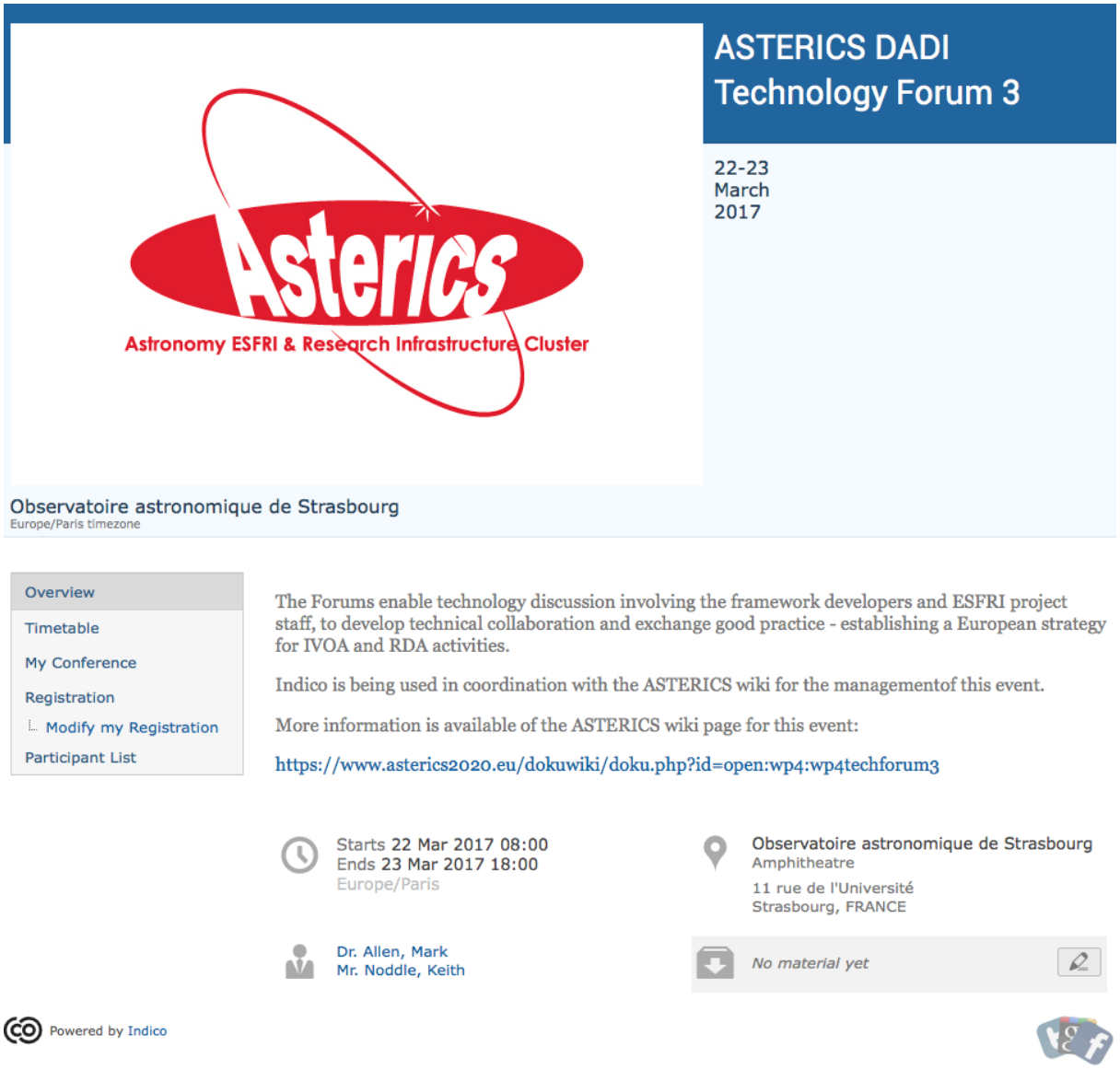


Figure 3: Technology Forum 3 registration website (https://indico.in2p3.fr/event/14260/)

3. Programme

The structure of the program followed the pattern used for the previous Technology Forums with an introduction followed by a set of presentations on current topics, and then sufficient time for the informal hack-a-thon sessions. The program of presentations was built from the proposed contributions submitted by the participants when they registered for the meeting. A number of presentations were solicited from the partners to ensure coverage of priority topics and representation of ESFRI activities. The program was developed by the chairs of the meeting with the help of the partners and was organised into sessions on “Feedback in Implementations”, “Implementations in ESFRI and other projects”, “Time Domain” topics and also “Tools, Standards and Libraries”. The program is available on the wiki with links to all of the presentations in pdf format.

Wednesday March 22		
10h	*Welcome and introductions*	Mark Allen
10h05-10h25	**DADI Status**	Françoise Genova
Session : Feedback on Implementations (Session chair : Mark Allen)		
10h25-10h40	**IVOA DAL WG projects / CDS implementations**	François Bonnarel
10h40-10h55	**Datalink and TAP demonstration in Aladin**	Chaitra
10h55-11h15	**IVOA GWS based implementation: interoperability feedback**	Sara Bertocco
11h15-11h35	**Current Status on the IVOA Provenance Data Model**	Mireille Louys
11h35-11h55	**RDA and DSA related topics in VAMDC (Certification and Query Store)**	Carlo Maria Zwolf & Yaye Awa Ba

Session : Implementation in ESFRI + (Session chair : Mark Allen)		
11h55-12h15	**CTA Data Diffusion**	Mathieu Servillat
12h15-12h35	**ESO Archive Services Project**	Alberto Micol
12h35	Lunch	
Session : Time Domain (Session Chair : Keith Noddle)		
14h-14h10	**Summary of Time Domain splinter meeting**	Dave Morris & François Bonnarel
14h10-14h30	**Implementation of Time Series DM**	José Manuel Alacid
14h30-14h50	**Simple Time Series in VizieR**	Sebastien Derriere
14h50-15h05	**Time Series Cube Data Model**	Jiri Nadvornik
15h05-15h20	**Semantics in the VAMDC infrastructure**	Nicolas Moreau
15h20-15h35	**Using Docker to manage service deployment**	Dave Morris
15h35-15h55	**Experiments with Docker and Spark**	André Schaaff
15h55	*Coffee Break*	
Session : Hackathon (Session Chair : Keith Noddle)		
16h10	**Hackathon Introdcution**	Keith Noddle
16h15	**Hackathon [2 rooms: Amphitheatre + Salle de reunion]**	

17h30	**Close**	
19h30	*Working Dinner*	
Thursday March 23		
Session : Tools, standards and Libraries (Session Chair : Mark Allen)		
9h-9h20	**RegTAP changes after VOResource 1.1**	Markus Demleitner
9h20-9h40	**TOPCAT recent visualisation enhancements**	Mark Taylor
9h40-10h	**Datalink implementation for stellar libraries**	Carlos Rodrigo
10h-10h30	**Discussion Session**	
10h30	*Coffee Break*	
11h-12h30	**Hackathon [2 rooms: Amphitheatre + Salle de cours]**	
12h30	*Lunch*	
14h-15h30	**Hackathon [2 rooms: Amphitheatre + Salle de cours]**	
15h30	*Coffee Break*	
16h	**Reports of Hackathon results**	
16h30	**Conclusions**	
17h30	Close	

4. Proceedings and Analysis

4.1 Setting the scene for the meeting

The introduction session set the scene for the meeting with a thorough overview of the status of ASTERICS DADI work package. This presentation highlighted the results achieved so far in terms of DADI deliverables and milestones, in particular series of DADI events since the beginning of the project (see Table 1). The review of the milestones, notably the IVOA interoperability meetings made it clear that the rhythm of having Technology Forum events in the 2 or 3 months prior to the major IVOA meetings (the 5 day IVOA meeting usually held in May each year) is of great strategic and practical benefit for maximising the ASTERICS DADI impact in the international context of the IVOA. From this review it was also apparent that our established cycle of meetings also favours the presentation of ASTERICS DADI results at the annual ADASS meetings typically held in October. The presentation also reported on the ASTERICS DADI impact at the level of the RDA plenary meetings.

The introduction reinforced the understanding of the schedule of the ASTERICS project, and the current status of being at the mid-point of the project. The ASTERICS mid-term review occurred only a week before the Technology Forum, and the initial very positive feedback received at the review was transmitted to the participants. A flow diagram of how the different ASTERICS DADI events feed into each other was presented along with details of the most recent events : The First European Data Provider Forum and Training Event (D4.6), the Second ASTERICS DADI School (D4.5) and the most recent IVOA interoperability meeting (M 26).

4.2 IVOA Review

The status of the IVOA was reviewed. There is significant ASTERICS participation in IVOA meetings in particular the contributions to the development of standards within the Working Groups and also leadership of these activities within IVOA. The contribution of ASTERICS to make large projects participants in the IVOA process is having a very positive effect with CTA actively participating in the development of the Provenance Data model. Another very visible contribution is the active participation of EGO/Virgo in IVOA meetings, expanding the IVOA into this new domain.

The review shows that IVOA was in the midst of a very active period involving the finalisation of a large number of new and updated standards. There are a number of topics of specific interest for the activities at this Technology Forum:

- **HiPS v1.0** – the Hierarchical Progressive Survey (HiPS) standard which is a scheme for the description, storage and access of sky survey data. This standard which is lead by

a DADI partner, was in the Request for Comments (RFC) period during the Technology Forum, a critical period for finalising the document before being proposed as an IVOA "recommendation".

- **SODA v1.0** – the IVOA standard for Server-side Operations for Data Access (SODA). This standard is part of the set of standards to support the multi-dimensional data priority area. SODA is a low-level data access capability for server side data processing that can act upon the data files, performing various kinds of operations: filtering/subsection, transformations, pixel operations, and applying functions to the data. This standard was in its review period by the IVOA Technical Coordination Group (TCG) during the Technology Forum requiring the final approval of IVOA TCG members, some of whom were participating in the forum.

- **DALI v1.1** – the IVOA standard for the Data Access Layer Interface (DALI). This standard is wide reaching because it is the base web service interface common to all Data Access Layer (DAL) services. It defines the common elements that are shared across DAL services in order to foster consistency across DAL service specifications and to enable standard re-usable client and service implementations and libraries to be written and widely adopted. This update to the standard was in an extended RFC period during the Technology Forum.

- **SSO 2.0** – the IVOA Single-Sign-On (SSO) Profile standard specifies the approved client-server authentication mechanisms. This major new version of this standard was at the end of the TCG review period during the Technology Forum.

- **ObsCore 1.1** – defines the core components of the Observation data model that are necessary to perform data discovery when querying data centers for astronomical observations of interest.

- **Recently approved IVOA standards relevant to ASTERICS DADI Technology Forum:**

    - **IVOA ID 2.0 –** that defines the syntax of globally unique name for a resource within the Virtual Observatory. Approved 23 May 2016, and relevant to implementations in services.

    - **SimDAL 1.0 –** the Simulation Data Access Layer protocol (SimDAL) defines a set of resources and associated actions to discover and retrieve simulations and numerical models in the Virtual Observatory -- Approved as IVOA Recommendation 20 March 2017, and relevant to increased focus on Theory data in the VO.

    - **VTP 2.0** – the VOEvent Transport Protocol, a major update to the IVOA standard defines a means of describing transient celestial events. Approved as an IVOA Recommendation 14 January 2017, and relevant to the time domain priority area.

- **Time Domain Priority area –** Following a very well attended Time Domain IG session at the May 2016 IVOA meeting the efforts for this priority area have been greatly increased, with higher level of participation and coordination including the UEDIN DADI member as Vice Chair of the relevant IVOA Interest Group.

- **Multi-dimensional Data priority area** – the set of standards for multi-dimensional data (ObsCore 1.1, SIA v2.0, DataLink 1.0, SODA v1.0) was in the final stages of completion, and final efforts at the Technology Forum were critical for preparing their approval as recommendations at the May 2017 IVOA meeting.

- **Provenance –** This quickly maturing area concerns the details of how provenance information for astronomical datasets can be modeled, stored and exchanged within the astronomical community in a standardized way. The IVOA Provenance Data Model is currently the subject of a lot of attention with specific drivers coming via ASTERICS DADI and the needs of the CTA project. Following a series of special ASTERICS DADI Provenance Day events (see Table 2) this topic was of high relevance at this Technology Forum.

4.3 Recent impact of ASTERICS DADI activities

Examples of the ASTERICS DADI impact were described, including the excellent visibility of ASTERICS at the ADASS XXV conference. This included an ASTERICS booth for interaction with ADASS participants. There were several talks at ADASS XXV on DADI topics including the use of interoperable tools for gravitational wave science, and also on the use of Data Models and High Performance Computing. ASTERICS WP5 CLEOPATRA was also represented at ADASS XXV.

Other impacts visible in the community are the collaboration between CDS and EGO on Aladin customization for the GWSky gravitational wave follow-up tool, the publication of ANTARES data in the VO by GAVO, and the decision of CTA to use the IVOA Provenance Data Model in its pipeline.

The perspective from the mid-point of the project is that it is clear that the initial expectations will be fulfilled and that ASTERICS DADI will have a legacy. The ESFRI and pathfinder projects are fully involved in the VO, and astronomy and astroparticle physics projects are working closely with common goals.

4.4 Highlights from the presentations

The participation of the ESFRI and pathfinder projects in the DADI work package is a key element for integrating these instruments into the VO framework. A major highlight of this

forum is the significant progress reported by CTA and by ESO on their integration of VO components in their work-flows and archives.

The CTA project reported on their integration of the IVOA Provenance Data Model into their data acquisition and processing work flow. This builds on the long term effort of CTA members contributing to the development of the concept and design of the provenance metadata in the IVOA, an effort which has been strongly supported by DADI via special meetings and "Provenance days".

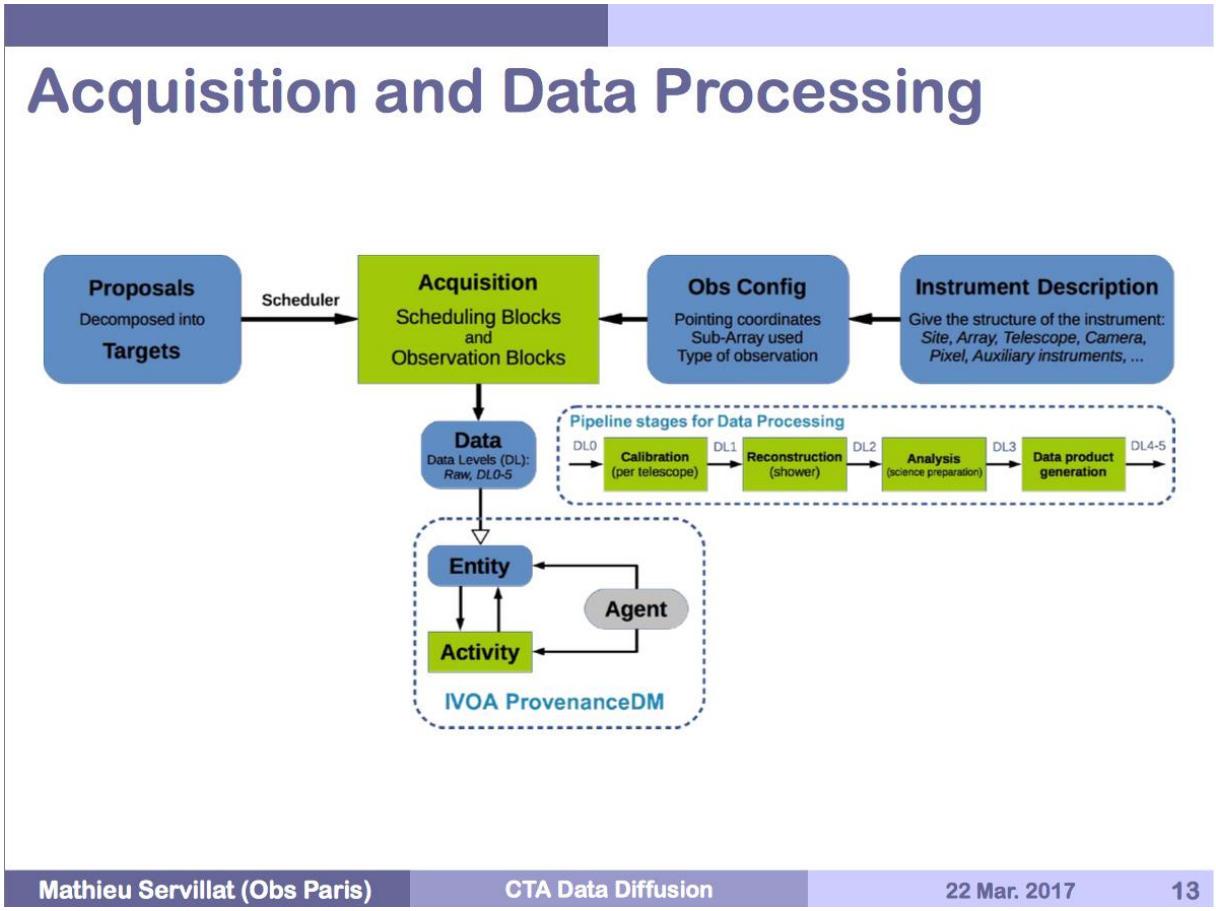


Figure 4 : CTA Acquisition and Data Processing workflow

ESO reported on their Archives Services Project to build new access services with the aim of maximising the scientific exploitation of the ESO data holdings. The projects is organised with 5 work packages including a Web interface, Preview capabilities, Programmatic and Tool Access, and Database Architecture. The plans presented show a deep integration of IVOA standards and the use of VO libraries and tools. This is a very important development which will ensure the interoperability of data from ESO instruments and will service as preparation for interoperability of data from ELT.

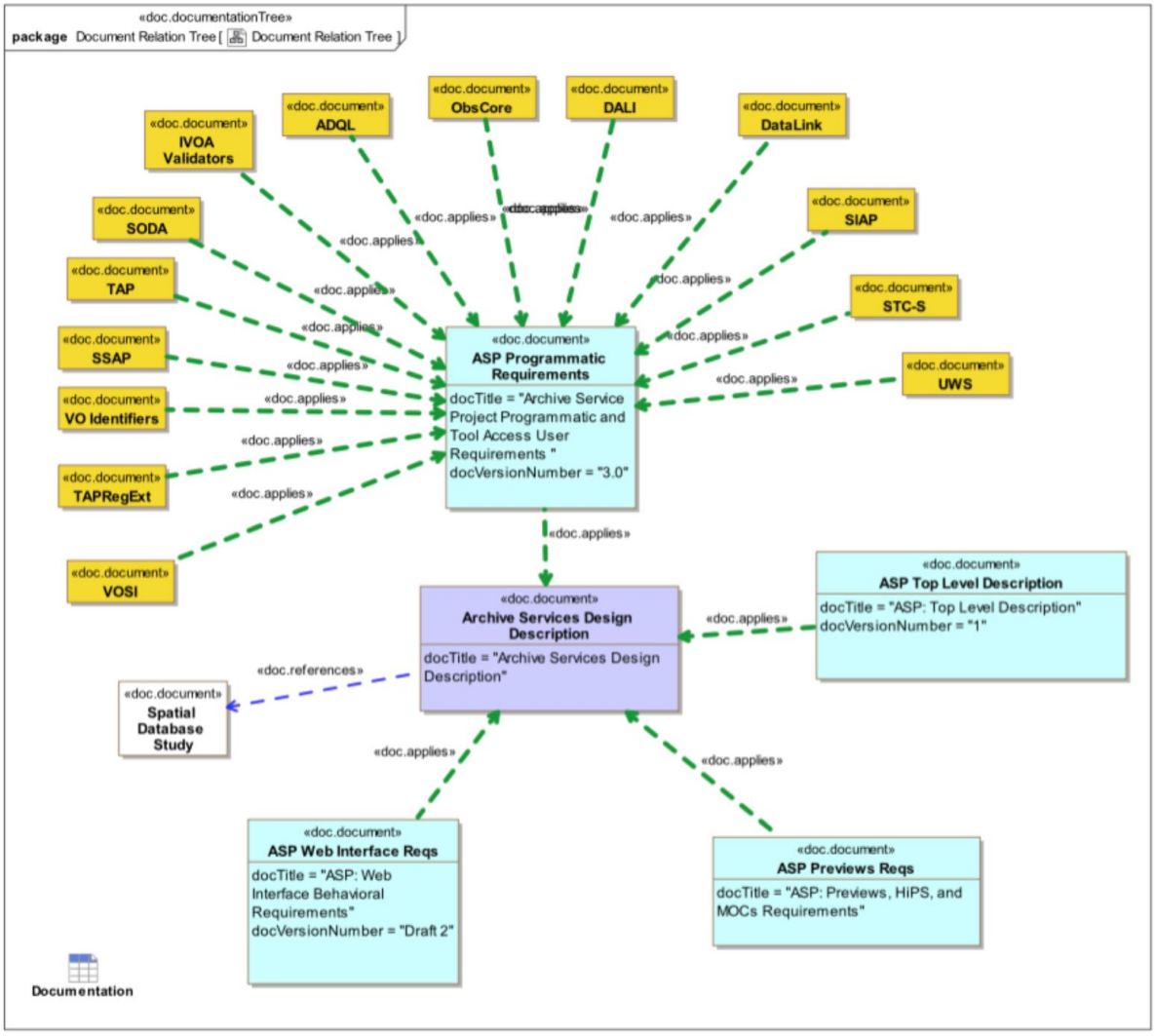


Figure 5: A slide from the presentation on the ESO Archive Project

Other highlights include the preparation of the final steps for the approval of the multi-dimensional data standards to satisfy the minimal requirements. A fully worked example of accessing data cubes was presented. This is of particular importance because providing access to multi-dimensional data is a priority of ASTERICS (and also a priority defined by the IVOA CSP).

4.5 Feedback on Implementations Session

This session concentrated on the results of implementing various VO standards in tools and services, gathering feedback on the technical aspects of using the IVOA standards and all of the real practical issues associated with writing code to enable VO interoperability. ASTERICS DADI partners play an important role in the whole cycle of IVOA standards development, following the IVOA Recommendation Process[2] and including reference implementations.

Data Access Layer standards

The latest news about the IVOA Data Access Layer (DAL) standards was presented by the current Chair of the working group. In addition to the standards for multi-dimensional data highlighted above, other important successes are: i) the approval of SimDAL for the discovery, description and access to theory data, and ii) the approval of VTP (VOEvent transport protocol), which defines communications of VOEvents in a network of brokers, publishers and clients. The latest updates of the IVOA standards DALI and TAP were also presented.

An analysis of the DAL standards shows that it is made up of a landscape of 14 different protocols, including new major versions of some protocols. A comparison of the functionalities provided by the different protocols for a range of different data types shows why this complexity is needed. Different practical approaches to implementing these protocols were discussed, emphasizing the role of reference implementations.

The future plans for the IVOA DAL working group were presented. These include:

- Discovery and access for time series data (in line with the time domain priority area). The use cases and requirements are to be consolidated, and prototyping is to be pursued in coordination with the Time Domain Interest Group and the Data model Working Group.
- Feedback on implementation of standards in the multi-dimensional data priority area
- Investigate the coupling of DAL standard with HiPS and MOC standards
- Follow-up of open questions on use of JSON format, PQL and PDL languages.

[2] http://www.ivoa.net/documents/#process

Implementation of DAL standards

The implementation of DAL standards in CDS services and tools was presented. A new prototype version of Aladin has been released with the major update enabling compatibility with latest VO standards. The new SIA v2.0, TAP and DataLink interfaces in Aladin were demonstrated. These capabilities have been implemented into Aladin as a new generic interfaces (not as plug-ins). One of the immediate benefits is the support of TAP queries on the ESA Gaia mission data, and the use of this generic interface as the basis for a more specific one for direct access to Gaia data in Aladin. The DataLink capability makes use of the ObsCore metadata (that is provided in ObsCore query responses) to provide service specific functions to the user. The new version of Aladin also includes a "discovery tree" directory of data that is built from IVOA registry records, and works as a visual interface to registry records for various types of services (HiPS, SIA, cone-search etc.)

Implementation of IVOA Grid and Web Services standards

A presentation on the EGI-Engage project reported on the exploration of authentication and data access interoperability of some services in a joint project between the Canadian Advanced Network for Astronomical Research (CANFAR) and INAF-Osservatorio Astronomico di Trieste (INAF-OATs). The SKA A&A community has expressed their interest in using the full software stack for user and access management. These parties are building experience on interoperating between two infrastructures.

Current status of the Provenance Data model

A detailed presentation on Provenance outlined the scope of the effort within ASTERICS and IVOA to define a Provenance Data Model. The relation of this work was also placed within the wider context of the W3C definition of Provenance. The work is guided by a set of rich and diverse use cases directly related to the CTA, RAVE, Pollux DB and SVOM projects. Working drafts of the proposal and also implementation examples are available on the IVOA document repository, and all of the activities around Provenance, including the ASTERICS DADI "Provenance Days" are gathered on the IVOA wiki site:

http://wiki.ivoa.net/twiki/bin/view/IVOA/ObservationProvenanceDataModel

It was also reported that a Provenance work package for interdisciplinary projects is under development in the RDA. The relevant RDA Groups are very interested by the IVOA work on provenance.

VAMDC implementation of RDA recommendation

VAMDC staff made a presentation on how the RDA recommendations on dynamic data citation and certification of data repositories fit with the VAMDC needs, and how they implement them. VAMDC was supported by the RDA Europe project to implement the "query store" which enables dynamic citation on distributed databases, an extension of the original recommendation.

4.6 Implementations in ESFRI and other projects session

Implementation of the VO framework in the CTA project and in the ESO archive are highlighted above. The presentations in the session outlined the details of these efforts and the discussions focused on the evolutions and modification of VO components needed to support these implementations. In the case of CTA the need for extension of the standard ObsCore fields were identified as necessary in order to support CTA data mining use cases. The detailed use of IVOA Universal Worker Service (UWS) standards was also discussed.

The ESO Archive Services Project is in its early stages and this first public description of the plans was very well received. The plan includes the use of standards for HiPS, MOC, TAP, TAPRegExt, SSA, SIA, ObsCore and Datalink. They expect to use established libraries for use of TAP (taplib) and also validators such as taplint and SSA validators. Aladin Lite is being considered for visualisation aspects. Their plans raised the question of authentication within some VO tools, and also the request was made for the development of libraries for DataLink. One important characteristic of the ESO archives that was reported in the presentation is that 78% of their data holdings are 1-dimensional spectra, which highlights the need for robust VO infrastructure and tools for spectra. One specific request related to spectra is whether the ObsCore and SSA UTYPES can be unified.

4.7 Time Domain Session

Presentations on the time domain priority were grouped into a single session and it is important to note that a special one-day meeting on time domain was held on March 21 preceding the Technology Forum.

Summary of Time Domain Meeting (March 21, 2017)

A summary of the discussion at the Time Domain Meeting was presented. A hot topic is the use of IVOA VOEvent in the event stream expected from future projects. The LSST and LIGO were considered as extreme cases. LSST will have a high volume "fire hose" of events, and gravitational wave experiments such as LIGO/EGO/Virgo will have very rare but "high value" events. The LSST system is being scoped to handle up to 10,000 transients in every 30 second visit in the raw unfiltered event stream, and in this case the concept of brokers and filtered streams has been developed. The meeting included a discussion of the importance

and challenges of implementing “replay” capabilities in processing of high volume event streams. The content and size of VOEvent packets is a critical issue for these systems, with discussion on whether ~1 MByte images can be included in these packets, and the alternative of providing links to images with the consequent load on servers for retrieval of the images. Another aspect is the level of description that needs to be provided on event streams so that they may be easily discovered.

The meeting served to re-focus time domain activities within DADI, and is part of a re-newed IVOA effort to coordinate the many different aspects of VO infrastructure to support time domain science. The next steps must be strongly guided by science use-cases developed by the various parties (including ASTERICS DADI partners) and coordinated via the IVOA Time Domain Interest Group.

Implementation of Time Domain services

An example of operational services for the Spanish Virtual Observatory (SVO) CoRoT and Integral OMC archives was presented. These are long term and well established services for time series which have been implemented and registered as SSAP services.

Other topics covered in the session included the time series data in the VizieR service and the significant work necessary to map such collections to standardized metadata. Looking forward however, data sets from large projects that take into account standardized metadata from the beginning will greatly facilitate their use in time series.

A specific topic of discussion was the lack of a good discovery mechanism for time series in the registry. It was noted that in contrast to previous efforts, we now have ObsCore and TAP for discovery.

The time series use cases and various assessments of the use cases and approaches were recalled during the presentations. It was generally agreed that the current increase in activity in this priority area, with new projects engaged, made it a good time to consolidate these previous efforts.

4.8 Tools, Registry Standards, and Libraries Session

Docker and Apache Spark Technologies

A number of presentations reported on experience with Docker and Apache Spark technologies. There is a high level of interest in Docker which can be used as a container for building and deploying VO services.

A series of tests for using Docker in deployments of services was reported, with a detailed study of the different file systems that can be used.

CDS services are being tested in Docker containers to address the issues of proving mirror service sites. The experience showed the need to manage packages that are not included in the standard apache image, and to decide on an update strategy appropriate for the management of mirrors of services. Deployment of Docker container mirrors of CDS services at a partner site is imminent.

Apache Spark is a cluster computing platform that is designed to be fast and general purpose. It extends the MapReduce model to support more types of computing – interactive queries, stream processing etc. and it offers APIs for various languages. Experiments with different use cases were reported, in particular for cross-matching of large astronomical catalogues. The results show that existing service architectures can be mapped to these new technologies.

IVOA Registry standards

The status of the IVOA Registry standards was reviewed by the current IVOA Registry Working Group Chair. The main topic addressed was how to maintain consistency of the group of standards relevant to use of the registry when some standards are being updated, with the current case being the new version of VOResource. VOResource is undergoing an update and it will be important for RegTAP, as the main user interface for the registry, to be updated to a version 1.1. The participants were encouraged to implement new VOResource features in registry records, and to contribute comments in the upcoming VOResrouce RFC**.**

Tools – TOPCAT: recent developments for visualisation capabilities.

TOPCAT is a VO tool for tabular data and has capabilities for accessing data via VO services. Recent improvements to the visualisation capabilities have been motivated by the need to address the use of time domain data, and also for exploration of large data sets. While these capabilities are becoming more and more complex, the TOPCAT development has maintained the duality between the interactive and scripting functions, so that everything you can do with point'n'click you can also do with the underlying STILTS command line.

A detailed presentation covered the new capabilities. Highlights include a new general time axis plotting function capability, multi-zone plots, and also enhanced support for HEALPix plotting functions.

The TOPCAT documentation has been improved in particular with greater use of images to support the use of the new visual features. Contact with participants of hands-on events including the DADI VO schools is important for interacting with users of these new capabilities. Feedback is also sought from the VO Time Domain Interest Group and also ESFRI projects.

4.9 Hack-a-thon Sessions

There were three Hack-a-thon sessions during this Technology Forum. The sessions were organised via an introduction and by participants submitting topics to the Hack-a-thon wiki page.

https://www.asterics2020.eu/dokuwiki/doku.php?id=open:wp4:wp4techforum3:hackathon

The detailed notes of the discussion are available on the Hack-a-thon page and were presented in the meeting.

A special hack-a-thon meeting was also held on March 22 before the official proceedings of the Technology forum (due to a timing issue) on the subject of how identifiers for Gravitational Wave events are used within the CDS SIMBAD and VizieR services. The notes and results of this meeting are included on the Hack-a-thon pages and were reported in the Hack-a-thon reports session.

5. Next Steps

The Shanghai IVOA Interoperability Meeting (May 14-19, 2017) was the next major event for DADI. Preparations for the IVOA meeting were done at the Technology Forum and were continued during the lead up to the meeting. The topics included:

- Preparation of ASTERICS DADI participation in time domain developments at IVOA
- Preparation of detailed input for the Provenance Data Model
- Final steps for standardisation of HiPS including a validator
- Final steps for standardisation of multi-dimensional data standards
- Authorisation and Authentication in particular SSO, and coordination of various partners with A&A experiments across different infrastructures
- Preparation to highlight the ASTERICS DADI supported implementation of VO standards in tools

The next DADI events will be the ASTERICS DADI School in November 2017, followed by the ESFRI Forum & Training Event 2 to be held in December 2017. The school will be organised by INTA in Madrid and the ESFRI Forum will be organised by INAF in Trieste.

6. Assessment of the relevance of the Technology forum with respect to the IVOA Shanghai Interoperability Meeting

The "Northern Spring" IVOA Interoperability meeting was held in Shanghai, China, 14-19 May 2017, with significant participation of DADI VO partners.

A short report was provided to deliver to EC as Milestone M26. The list of talks related to topics discussed in DADI which were presented during the meeting is attached to DADI Repository of products here:

https://www.asterics2020.eu/dokuwiki/doku.php?id=open:wp4:dadiproductrepository

IVOA Standards: The IVOA reached a milestone with the completion of the set of standards dealing with multi-dimensional data (DALI and SODA were approved during the meeting) - which were also one of the two DADI initial priorities. The second priority, time domain, is now very actively tackled (two dedicated plenary session and one splinter session, plus input to other sessions), input from DADI partners and activities (in particular the Technology Forums and the specific meeting held in March in Strasbourg) being key for the endeavour. Dave Morris (UEDIN) was designated as Vice Chair of the IVOA Time Domain Interest Group in 2016, and Ada Nebot (CDS) as Chair during the Shanghai Interoperability meeting. HiPS and a new version of the IVOA SSO standard, which are of high interest for DADI community and were made possible by work done within the project, were also approved as IVOA Recommendations during the meeting.

The Science session included Theory and Time Domain talks. Comparison of observational and theoretical results were identified as a requirement of large projects at the 2016 Cape Town Interoperability meeting. This confronts IVOA activities to provide an interoperability framework for theory. The possible DADI role in that domain is to be explored.

The excellent Education and Outreach session including well received presentations of DADI activities. Hendrik Heinl (UHEI) was designated vice-chair of the IVOA Education and Outreach Interest Group.

Cross-project aspects: liaison with other projects has been on-going since nearly the beginning of the IVOA.

- Active presence of solar system community, which is aligning its own standards with the IVOA ones in the framework of the Europlanet project. Creation of an IVOA Solar System Interest Group in Shanghai. Input from that community to many IVOA WGs to improve alignment. They have in particular an excellent practice of the time domain.
- The Virtual Atomic and Molecular Data Centre community has also been present from its origin. They are updating the relevant IVOA standard and present their implementation of RDA recommendation on dynamic data citation.

- As usual, the Interoperability meeting was also used to discuss the RDA activities and their interest for astronomy.

7. Conclusions

The Third ASTERICS DADI Technology Forum completely fulfilled its purpose of sharing information between DADI members and served to prepare input for the May 2017 IVOA Interoperability Meeting. The proceedings and analysis showed excellent progress of DADI activities in particular the implementation of VO components in ESFRI and other projects. DADI supported development of IVOA standards has reached an important milestone for the multi-dimensional data priority with these standards ready for implementation and feedback. The time domain priority area is now better coordinated via new leadership from ASTERICS at IVOA. In developing areas the Technology Forum provided an environment to informally investigate the possibilities with immediate feedback from peers. The next steps were defined, and an assessment of the relevance of the Forum with respect to the IVOA Interoperability Meeting that followed in May 2017 reinforced the DADI methodology and approach.

Figure 6: DADI Technology Forum 3 group photo