

## Toward an AVO Interoperability Prototype

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**Abstract.** As part of the Astrophysical Virtual Observatory (AVO) we are developing an interoperability prototype which aims to federate a set of astronomical archives, representative of a variety of techniques (space/ground, images/spectra, X-ray to radio wavelengths) into the CDS VizieR and Aladin tools. The target archives for federation are: VLT, NTT, EIS (ESO), HST/ECF, ISO, XMM (ESA), Wide field UK archives, MERLIN, and Terapix. We demonstrate the interoperability of these federated archives with examples using multi-wavelength image data and catalog overlays, and highlight new functionalities of the federation and integration tools.

### 1. Introduction

The Astrophysical Virtual Observatory<sup>9</sup> (AVO) project is a pilot program for construction of a European Virtual observatory, and participates in the International Virtual Observatory Alliance. An important first year milestone of the AVO project is to implement an interoperability prototype with the goal of federating a set of key data archives into the CDS interoperability services. The aims for the prototype system are to:

- Evaluate interoperability tools in terms of usability and function.
- Drive specifications and development of new functionalities.
- Provide a test bed for new and evolving standards (UCDs, VOTable).

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- Enable early science usage of Virtual Observatory like tools and get feedback from users.
- Heighten awareness about basic interoperability requirements among the archive providers.
- Compile a set of practical interoperability recommendations

## 2. AVO Interoperability Prototype

The prototype is based on the existing interoperability tools at the CDS, namely the VizieR catalogue browser, and the Aladin sky atlas image tool. VizieR (Ochsenbein, Bauer & Marcout 2000) and Aladin (Bonnarel et al. 2000) gather and maintain metadata about catalogs, data archives and image servers. Using this metadata, the interfaces provide access to catalogs, images and remote resources for browsing, downloading data and visualization in a single environment.

The CDS systems offer a working framework in which to test and develop high level metadata definitions and standards required for Virtual Observatories. Units and Uniform Content Descriptors (UCDs) (Derriere et al. 2002, 2003) are already defined for all archives and catalog in VizieR, providing a working development platform which is complementary to parallel developments of distributed metadata systems and web-service type operations (e.g., Szalay et al. 2002).

## 3. Target Archives

The target data archives for inclusion in the prototype consist of European data archives chosen to be representative of space and ground-based observations over a wide range of wavelength. The target archives include VLT, NTT, EIS (ESO), HST/ECF, ISO, XMM (ESA), Wide field UK archives, Jodrell Bank radio archives, and Terapix data.

The prototype system provides interoperability between these archives at the *data level*, meaning that coordinate systems of images from the different instruments and telescopes can be combined to create mosaics and overlays. This is done via the Aladin tool, which matches images by re-orientation and scaling, see Figure 1.

## 4. Recent Enhancements

Recent enhancements have been implemented in the Aladin and VizieR tools to facilitate display of radio images, and to allow the possibility of making astrometric registration adjustments for image alignment based on common image features. Other improvements to Aladin, driven by the prototype, include a facility to generate, display and manipulate contour plots of images, and to combine registered images into a RGB colour composite.

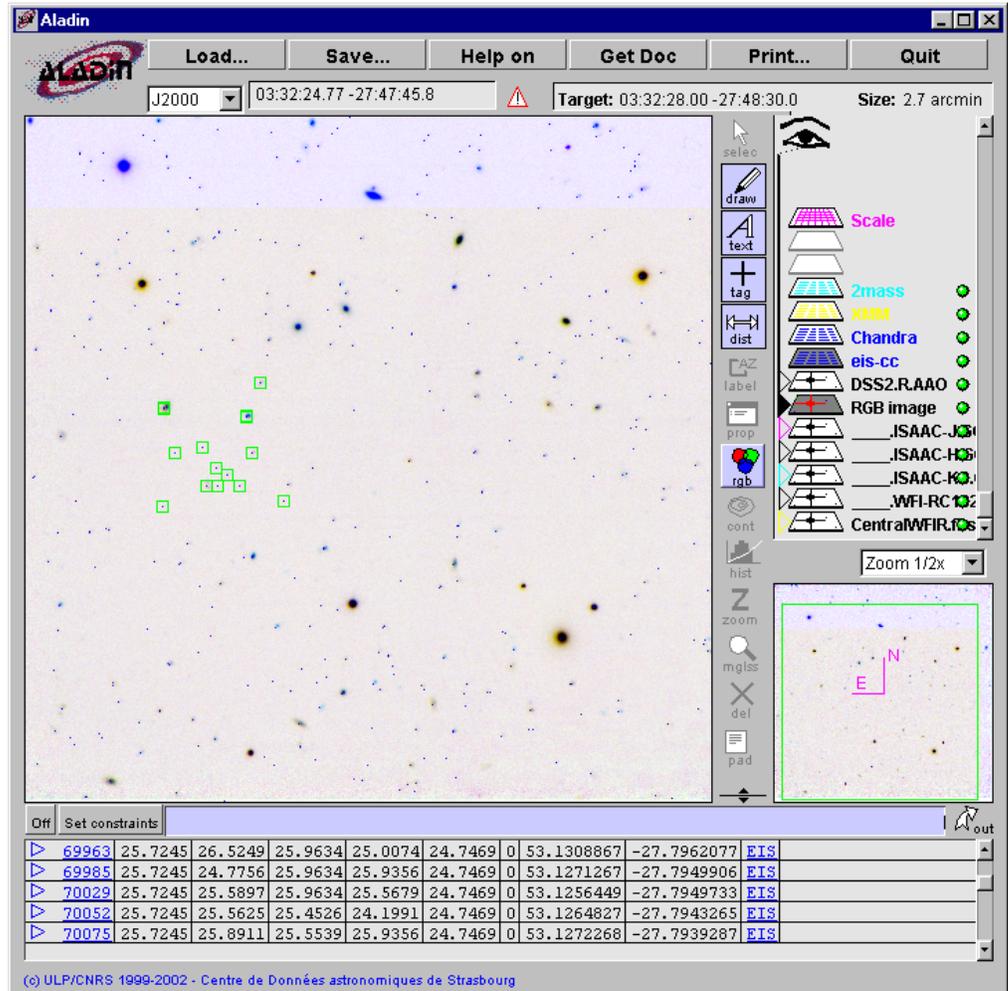


Figure 1. Aladin Sky Atlas. This figure shows a number of the interoperability prototype target archive images and catalogs loaded into Aladin. The image is a colour composite of VLT ISAAC J, H and WFI-R frames of the central part of the Chandra Deep Field South. The image is overlaid with EIS point source catalog, with selected catalog values shown in the lower panel. Also available in the image/catalog stack are locations of XMM and Chandra observations.

## 5. Practical Recommendations for Interoperability

Implementation of observatory observation log files into the interoperability system currently requires significant interaction with the archive holders. This process identifies the required metadata definitions to properly describe a remote resource. In some cases this process stimulates archive holders to review their archive exposure mechanisms. Lessons learned from archive implementation are being systematically reviewed to produce a set of interoperability recommendations to archive providers. The basic requirements for implementation are the availability of direct HTTP access to archive images, and that astrometry information is supplied in the FITS World Coordinate System. For “living” archives, such as a growing observation log, a simple mechanism is required for updating the metadata. Emphasis is also placed on including uncertainties and errors on measurements where possible, and on the inclusion of auxiliary information such as filter transmission curves. Data rights and access are also key questions to be addressed by archive holders prior to interoperability implementation.

## 6. Conclusions

The AVO interoperability prototype is implementing an increasing set of European data archives into the CDS VizieR and Aladin, making these data available for early science usage. The prototype provides a test bed for development of metadata descriptions and standards, and of new functionalities for working with multi-wavelength data. The requirements of the prototype have driven the developments of new functionalities such as RGB and contour displays, and additional developments and customizations are also being driven by the requirements of the AVO Early Science Demonstration foreseen for early 2003.

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