

EXPRESSION OF INTEREST

to subsequently submit a proposal to the Sixth Framework Programme for an Integrated Project in the field of

Enabling a Virtual Observatory for Europe

Acronym – EVOE

Call Identifier – EOI.FP6.2002

Thematic Priorities – 1.1.2.iv, 1.1.2.i, 1.1.2.ii

1 Summary

Based upon the experience, studies and prototypes created within the Astrophysical Virtual Observatory (AVO) Phase-A RTD project, a consortium formed around the nucleus of the existing AVO alliance of 6 major data management and technology organizations will submit an Integrated Project proposal under FP6 for the creation of a pan-European virtual observatory (EURO VO). This proposal will involve the creation of an R&D alliance with all major astronomical data centres in Europe and the points of origin of data creation - observatories and space science centres as well as theoretical astrophysics centres. The alliance will conduct coordinated R&D in VO systems and technologies building on the foundations laid by AVO and utilizing Grid middleware, Grid production-class infrastructures and European networking being developed as part of the FP6 priorities. Effort will be deployed to major data centres to take up new AVO technologies via the migration of data holdings to AVO structures, interfaces and metadata standards. This action will enable Europe-wide data holdings to be retrieved, navigated, modelled, visualized and interpreted by the astronomical research community achieving e-inclusion through common, interoperating and production-class VO interfaces and tools. The alliance will enable the dissemination and transfer of knowledge on grid technologies throughout European astronomy via training and support for the development of new science-program-specific tools. The knowledge gained on interoperation of data resources can also be transferred to other data-intensive disciplines and business activities. Via continuing R&D and international collaborations with VO efforts in the Americas and the Asia-Pacific region, the EVOE project alliance will ensure users of the EURO VO have access to global astronomical resources and that the EURO VO plays a leading and critical role in the development of common VO technologies.

2 Research rationale

Astronomy, like many other physical sciences, has reached a crisis point for the execution of large national and international research programs. The fundamental questions facing astronomy and astrophysics in the last decade of the 20th century required the creation of new research facilities (like the ESO VLT) whose investments and collaborations are on the international scale. An array of new ground and space observatories were inaugurated that now collect data across large sections of the electromagnetic spectrum. For distributed communities of researchers to solve complex problems with these facilities, a new research infrastructure is required. In

many cases, the data volume involved with fundamental problems can no longer be readily processed, explored and exploited on the desktops of individual astronomers. Researchers must now turn to the Grid paradigm of distributed computing and resources to conduct competitive research programs. A necessary step to utilize this new IT paradigm is to join the existing astronomical data centres and archives into an interoperating and federated unit. This new astronomical data resource will effectively form a Virtual Observatory (VO) in which the digital Universe resident in the new archives can be seamlessly retrieved, navigated, modelled, visualized and interpreted across the entire spectrum. In much the same way as a real observatory consists of telescopes, each with a collection of unique astronomical instruments, the VO consists of a collection of data centres each with unique collections of astronomical data, software systems and processing capabilities. The interoperability necessary to make the VO a multi-wavelength window into the Universe will also allow the reuse of past, present and future data reservoirs for purposes beyond their originally specified research targets.

In November 2001 an RTD initiative under FP5 entitled the Astrophysical Virtual Observatory (AVO) (HPRI-2001-50058, <http://www.eso.org/avo>) was launched to conduct a three-year Phase-A R&D program on essential technologies and systems for a VO for European astronomy. The project, lead by ESO, brings together six major European astronomical data providers and technology R&D programs. The AVO work program focuses on the three areas of Science Requirements, Interoperability and Technologies. By implementing test-beds for interoperability interfaces and standards, as well as initial implementations of Grid technologies, the AVO Phase-A program will support the implementation of trial science cases. These efforts are being conducted in close collaboration with similar programs in the US (NVO) and Asia-Pacific region so that a truly international virtual observatory will be possible. Already, within the first six months of the AVO work program, a new standard for the interoperation of tabular data has been developed and adopted by the AVO and NVO communities.

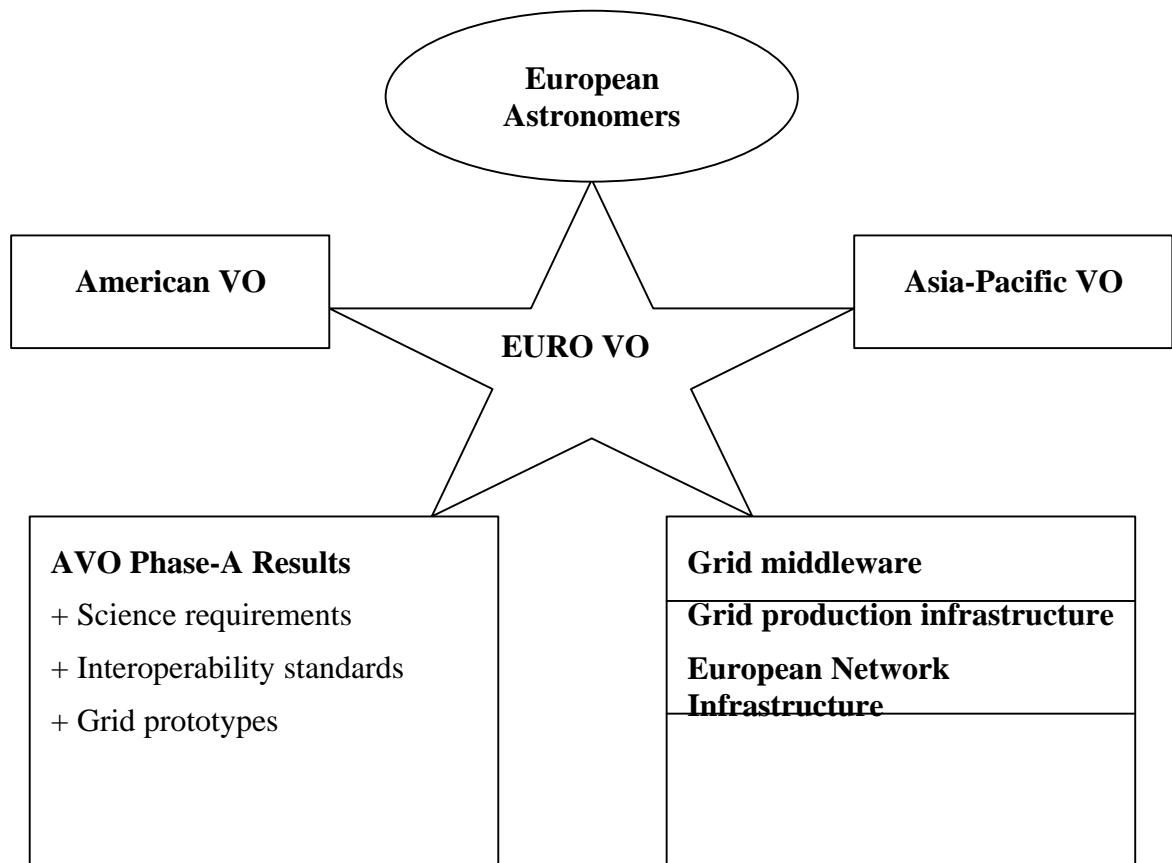
Once the objectives of AVO Phase-A have been met, the AVO project consortium wishes to join with the broader European community of data centres to begin a Phase-B work program which will make AVO developments available to all data creators, data holders and the general European research community. This new work program will be an Integrated Project that draws together the critical mass of European expertise in astronomical data management to facilitate the deployment and further development of common interoperability and grid-based technologies for the European VO. It will also enable the development, distribution, and support of production-class tools and interfaces for access to, and utilization of, the pan-European VO and associated global VO sites. This Integrated Project will rely upon developments in Grid middleware and European networking which are also priority areas of FP6.

3 Objectives

The EVOE Integrated Project will have the following primary objectives:

- To form a pan-European R&D collaboration of all major astronomical data centres which represents the critical mass of astronomical data holdings necessary for a multi-wavelength (space and ground) EURO VO

- To consolidate the lessons learned from the AVO Phase-A RTD Project in respect of level-1 science requirements, interoperability standards and technology requirements, into a 4 year roadmap for the deployment of a European VO facility
- To implement interoperability interfaces and associated data standards at the EVOE set of data centres, enabling further developments were necessary for new data types and instrument capabilities
- To deploy assistance to a wider collection of pan-European data centres to enable the take-up of new technologies and the transformation of holdings to new AVO interoperability and technology standards
- To move AVO testbed systems for VO interfaces, services and tools onto a production level footing enabling the e-inclusion of the broader astronomical community
- To form a close coordination between EVOE centres and developers of the European research physical network infrastructure to ensure the needs of the VO community are met and to enable connectivity at the appropriate level at the earliest possible date
- To directly involve EVOE centres with FP6 Grid initiatives in the specification of requirements for Grid middleware and production infrastructure and to promote and support the use of Grid systems in the European VO community through training, dissemination and prototype development programs
- To enable the development of science-specific knowledge discovery tools as the "instruments" of the virtual observatory flowing from solicited scientific proposals
- To initiate dialogue and research relationships with European industry in key VO and Grid technology areas such as networking, database design and storage management
- To consolidate collaborative links to similar efforts in the US and Asia-Pacific region with the specific objective of making the European VO system an integral and leading component in the global VO system thereby giving European astronomers access to important datasets
- To enable the transfer of knowledge and experience on interoperation of data resources with other scientific disciplines, society activities and industry
- To enable the use of VO technologies and the e-inclusion of the broader European community of educators and citizens through the development and deployment of specific learning and knowledge discovery systems in collaboration with educational and outreach initiatives of the member organizations.



4 General approach

The EVOE Integrated Project will create a collaborative R&D alliance between all major astronomical data centres in Europe. This alliance will

- conduct coordinated R&D on VO systems and technologies
- make its data holdings and processing facilities available to the general European astronomical community through a common and unified set of VO interfaces, standards and systems utilizing grid technologies where appropriate
- support scientific research programs through training, the provision of common, production-class tools and by providing assistance for the development of new software tools ("virtual instruments")
- ensure the effective interoperation of EURO VO data holdings and systems within the global VO effort

The EVOE project will build on two foundations. Firstly, the recommendations, analysis, assessments and prototypes of the AVO Phase-A work program will be used to define the requirements for production-level services and systems for the EURO VO. Secondly, via membership of AVO Phase-A in the EC funded GRIDSTART accompanying measure, the EIROFORUM Grid Group and other international associations (e.g. GGF) the EURO VO will identify elements of Grid middleware, Grid infrastructure and European networking (developed as part of the ERA) that will form the production environment of services and tools. The EVOE Integrated Project will depend on close links with Grid programs to ensure training and the dissemination of development and requirements. The EURO VO will form a strong international collaborative relationship with similar efforts in the Americas and Asia-Pacific to

ensure there are no barriers to global VO access for European astronomers. The EURO VO will be available to the broad astronomical community of Europe as a portal to the wealth of multi-wavelength data resident in the archives of 21st century European astronomical facilities and as a gateway to global astronomical resources thereby facilitating distributed, competitive international research programs.

5 Need and relevance

The AVO Phase-A RTD was fully supported by the OPTICON Thematic Network (FP5) on optical and infrared astronomy in Europe as a key strategic initiative for European astronomy in the first decade of the 21st century. The AVO proposal also formed links with a similar thematic network in radio astronomy (RadioNET) via in the inclusion of the Jodrell Bank Observatory in the proposal. This European recognition of the need for VO development has also be echoed by similar recommendations in the US Decadal Survey of Astronomy and associated funding by the NSF and NASA. Funded VO programs now also exist in Canada, India and Japan as well as major funding applications in Australia, Germany and Russia. There is a globally recognized and prioritized need for the development and deployment of VO facilities and services in astronomy, which will be achieved as part of the development of Grid technologies.

The EIROFORUM grouping of European Intergovernmental Research Organizations Directors General (CERN, EMBL, ESA, ESO, ESRF, ILL and JET-EFDA) was formally launched in May 2001. The charter of the EIROFORUM states that the EIRO group will place its expertise at the service of the European Research Area to facilitate discussion among EIRO group members on issues relevant to ERA developments and to optimize the use of resources and maximize the scientific return by sharing relevant developments and results.

Given the critical dependence of the success of 21st century research programs on the availability and performance of information technology and recognizing the current move towards a new, distributed computational infrastructure (the Grid), EIROFORUM has established mechanisms to ensure coordination and collaboration in the development and utilization of Grid technologies among EIROs. This coordination will further the dissemination and utilization of Grid capabilities within the various research communities of the ERA and thereby strengthen the research capabilities of Europe. Given the high priority assigned to developments in the Grid area by EIROFORUM, the AVO and the EVOE projects will be coordinated with similar Grid applications within the EIRO grouping to maximize the EC return on investment and dissemination of Grid technology for the ERA.

6 Scale of ambition and critical mass

The group of 6 original AVO Phase-A members (ESO, ESA(STECF), ASTROGRID, CDS, TERAPIX, Jodrell Bank) represents a large amount of the expertise for astronomical data management in Europe. It does not represent the entirety of the range of data holdings, particular with respect to wavelength and uniform sky coverage. The EVOE IP will draw together a total of 20 archive sites in Europe. Some sites in Australia may join the IP under Australia's associate status in the FP. Via

international coordination, another dozen archive sites from the US, Canada, South America, India, Russia and Japan will become available within the VO services. The multi-wavelength coverage from low frequency radio to gamma rays necessary to solve fundamental problems in astrophysics will require this critical mass of archive centres covering space and ground observatories.

7 Integration

EVOE will integrate a wide range of activities to maximize the benefits of the project to European astronomy.

- **Research** efforts will be supported through the assistance given to VO users to create specific “virtual instruments” to explore the VO digital Universe. Based on the tool prototypes developed on the basis of AVO Phase-A science cases, the development of new tools will be supported via manpower at the EURO VO partner data centres. This exploration will be extended to virtual universes of numerical simulations and models which are important components in the scope of VO data holdings.
- **Technology** for VO science will be developed in a coordinated manner based on AVO prototypes. This technology will largely fall in the areas of databases design and construction, scalable storage and computing systems and Grid methods.
- **Unification of European data holdings** by deploying assistance to a wide range of data holders to enable migration to new AVO standards, interfaces and technologies.
- **Testing and Deployment** of VO systems will continue through the course of the IP as new data centres are added, new data types are incorporated and new Grid technologies and services become public.
- **Resources** for VO services and development (e.g. storage hardware, computing hardware, database systems) can be shared and optimized within the VO/Grid model.
- **Outreach and Training** for the European astronomical community can be achieved in a coordinated manner through the EVOE IP via the running of workshops and tutorials at a national level and by the utilization of grid technologies in the wider research community.

8 **Conclusion**

The need for the development of VO technologies is now well recognized by the global astronomical community. The AVO Phase-A RTD under FP5 will lay the essential R&D groundwork to demonstrate VO prototype functionality among targeted data sets within the original 6 member organizations. To make these facilities available to the wider European astronomical community and to join a critical mass of multi-wavelength data holdings into an interoperating whole, capable of sustaining production-level activities, the AVO project alliance must be extended to a grouping of all the major astronomical data centres and data producers in Europe. This new alliance for R&D on VO technologies and services will submit an Integrate Project proposal to FP6 to support the creation of a EURO VO capable of providing production level services, training and development support to European astronomical research. The EURO VO will play a leading and critical role in the interoperating alliance of global virtual observatory systems.