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Scoping the UK's Virtual Observatory: AstroGrid's Key Science Drivers

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Abstract. AstroGrid, a UK e-Science astro-informatics project, with collaborating groups drawn from the major UK data archive centres, is creating the UK's first virtual observatory. AstroGrid is aiming to support a broad spectrum of astronomical activity, with an initial emphasis on meeting the needs expressed by the UK community. This paper discusses how AstroGrid is balancing the scientific requirements of the community (which includes the Solar and STP communities). Note is made of the use of interactive mechanisms provided by the project, especially those linked through the AstroGrid portal, in capturing user requirements.

1. The AstroGrid Project

AstroGrid[1] is one of three major funded world-wide projects (along with the European Astrophysical Virtual Observatory[2] (AVO, Quinn 2002) and US National Virtual Observatory[3] (NVO, Hanisch 2002) which are aiming to create an astronomical Virtual Observatory.

AstroGrid will develop a working implementation of immediate use to astronomers. As a consortium of UK data centres and software providers, AstroGrid aims to pool common resources, including key UK databases, storage, and compute facilities. As a UK e-Science project, its architecture is firmly based on a service/data-grid approach: making use of grid components produced by other

[1] `http://www.astrogrid.org`

[2] `http://www.euro-vo.org`

[3] `http://www.us-vo.org`

projects, with AstroGrid developed components being made freely available to the community. The scientific aims of AstroGrid are:

- to improve the quality, efficiency, ease, speed, and cost-effectiveness of on-line astronomical research,
- to make comparison and integration of data from diverse sources seamless and transparent,
- to remove data analysis barriers to interdisciplinary research, and
- to make science involving manipulation of large datasets as easy and as powerful as possible.

The Virtual Observatory (VO) will be a set of co-operating and interoperable software systems that will allow users to interrogate multiple data centres in a seamless and transparent way. The VO will provide powerful new analysis and visualisation tools and give data centres and data producers (e.g., projects, observatories, individuals, etc.) a standard framework for publishing and delivering services using their data.

2. AstroGrid Development Activities

In its first year AstroGrid has been undertaking activities in a number of areas, with the primary emphasis being to capture the science requirements required to scope the project, together with the development of a project architecture within which the required capabilities (such as authorisation, see Rixon & Walton 2002) can be developed. Subsidiary activities have included engagement with the other international VO projects, closely with the AVO where AstroGrid is a formal partner, and informally with projects such as the NVO. Important activities such as agreeing low level interoperability standards have been undertaken within the context of the International Virtual Observatory Alliance.[4]

3. The AstroGrid On-line Collaboration Tools

AstroGrid has deployed a set of ground-breaking collaboration tools which have enabled team members to share experiences, seek opinions and expert advice, and create an extensive library of documents pertaining to all aspects of the project. These tools, linked from http://www.astrogrid.org, are

- **News:** [`http://news.astrogrid.org`]— The news site is to announce issues of interest, including details of AstroGrid product releases.
- **Forum:** [`http://forum.astrogrid.org`] — The forum is an area where discussions related to the development of the project can be initiated.
- **Wiki:** [`http://wiki.astrogrid.org`] — The wiki is where all AstroGrid project documentation is not only stored but also developed. The wiki is an area where documents can be edited by public users, with version control enabling differences between versions to be tracked. The wiki has proved itself to be extremely useful in the development of the science and user requirements.

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[4] `http://www.ivoa.net`

These collaborative and open sites have proved to be essential for enabling the operation of the distributed development teams that make up the personnel of the project.

4. Capturing the Science Requirements

AstroGrid has generated and gathered key science cases. Because the consortium contains representatives involved in a wide range of UK astronomy, solar and STP research activity, a broad range of science cases stressing areas such as radio astronomy, solar physics and solar/terrestrial physics has resulted.

In the first instance a number of specific use cases were formulated. These were often concerned with how a part of science problem might be approached, for instance, running a query on a database to locate and show the positions of known QSO's. Other cases are aimed at easing the process of acquiring sufficient data to address a particular problem, e.g., returning the colours of galaxies and their bulges as a function of redshift to study alternative theories of galaxy evolution. The distinction between 'science cases' and more generic 'use cases' rapidly became apparent. Emphasis was placed on capturing and formalising the science cases.

4.1. Scoping the AstroGrid Science Drivers

An extensive list of requirements, documented as science problems,[5] were gathered. This selection of science drivers will be continually expanded upon throughout the project lifetime. A formal and rigorous process was undertaken in order to select a well defined subset of science drivers, the AstroGrid 'Ten,' which would be used to shape the AstroGrid deliverables.

4.2. The AstroGrid 'Top Ten' Science Drivers

The AstroGrid 'Ten' science cases have been selected as they demand the delivery of a set of capabilities that will be relevant to aiding scientific output in these topical science areas.

- Discovery of High Redshift Quasars (Astronomy: involves optical and near-IR data sets)
- Locating galaxy clusters at a range of redshifts. This will be linked to predictions from model data. (Astronomy: Models)
- Brown Dwarf selections (Astronomy: involves optical and near-IR data sets)
- Deep Field Surveys (Astronomy: involves linking radio with other data on deep fields such as the Hubble Deep Fields).
- Low Surface Brightness galaxy discovery (Astronomy: optical, near-IR, radio, X-ray)
- Supernova galaxy environments (Astronomy: Optical)
- Solar Stellar Flare Comparison (Astronomy, Solar: linking understanding of solar flares with those seen in stellar events)

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[5] `http://wiki.astrogrid.org/bin/view/VO/ScienceProblemList`

- Solar Coronal Waves (Solar: unraveling this phenomenon)
- STP Solar Event Coincidence (STP and Solar: links solar data with STP data in understanding space weather)
- Magnetic storm onsets (STP: federation of in-situ and remote sensing data)

These science topics encompass a wide cross section of areas, and include drivers aiming to bridge subject area gaps. The capabilities demanded by these drivers are seen as being of use more generally in the support of other areas of astronomy. The ten key science problems have been selected to enable the project to be scoped to ensure that a Virtual Observatory capability is generated by the end of the AstroGrid Phase-B period (i.e., end 2004).

5. Architecture Development

For each science driver a typical flow of events was constructed, decomposing the tasks required to complete that process. Sequence Diagrams were thus generated for each of the science cases, and for the generic technical use cases (these covering activities such as negotiating access to jobs, login to the system, etc.). The sum of these tasks represents the components of the system that are required to form the AstroGrid Phase-B product, to be developed within the framework laid down by the project architecture. A complete review of the AstroGrid project is to be found in its Year 1 report.[6]

6. Concluding Remarks

AstroGrid will provide tools and capabilities to help the researcher in producing solutions to these science topics. AstroGrid will not in itself provide the answers, the astronomer will be presented with new capabilities to aid their research. This will be especially so in the areas of data discovery, transformation of data into information via access to processing facilities, and management of the processing flow of events. The researcher will be able to devote more time to the understanding of the astrophysics revealed by their results, more time can be given to the important step of transforming information into knowledge.

References

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[6] `http://wiki.astrogrid.org/bin/view/Astrogrid/PhaseAReport`