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A Domino-based Virtual Observatory Service for the HI Parkes All Sky Survey

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Abstract. The current development of globally accessible astrophysical data systems is increasingly embracing Grid computing concepts, with data description and formatting standards such as VOTable and Uniform Content Descriptors providing a basis for system-system interoperability. To date, a diverse set of database management systems have been used for catalogue storage within these systems. We present a Virtual Observatory service for the HI Parkes All Sky Survey, implemented on an IBM Lotus Domino R6 database management system. Domino's distributed computing architecture, with in-built support for replication and clustering, sets it apart from more general database systems as being inherently suitable for Grid computing applications.

1. Introduction

The neutral atomic Hydrogen (HI) Parkes All Sky Survey (HIPASS), undertaken in the period 1997 to 2001, has previously been described in ADASS proceedings (Barnes 1998; Barnes et al. 1998). Since completion of the survey, HICAT — a catalogue of all sources detected in the southern sky images — has been generated and lists the basic integrated HI properties for more than 4,300 galaxies (Meyer et al. 2004). One of the primary tasks of the Australian Virtual Observatory (Aus-VO) in its first year of operation (2003) has been to publish HICAT and make it available to astronomers around the world.

We present an overview of HICAT after migration onto a Lotus Domino R6 backend. Brief implementation details, general and Virtual Observatory service facilities available and future system directions are covered. The functionality shown has been tested with Microsoft IE 6, Lotus Notes 6.0.3 and Lotus Domino Designer 6.0.3. VOTable output is compliant with VOTable version 1.0.

2. HICAT Virtual Observatory Service on Domino

The HICAT Domino database currently stores 4,329 source documents, each with 172 data fields. Of these 172 data fields, 34 have been assigned Uniform Content Descriptor parameter equivalents and associated VOTable metadata. Over the Web, survey data is presented to users through the Domino view applet, allowing view column resizing and sorting on a user-selected column. The Web interface is presented in Figure 1. In addition to displaying source data through

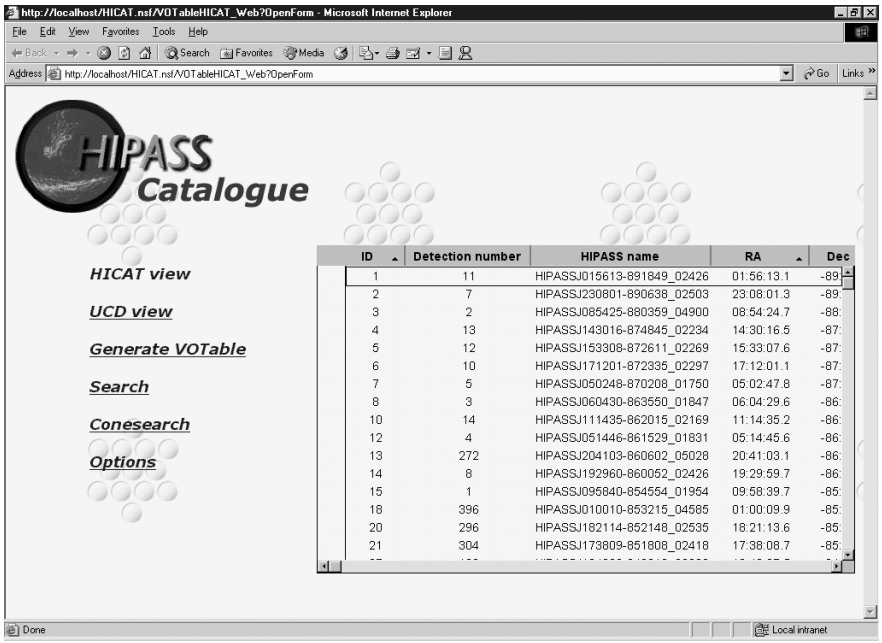

Figure 1. The Web interface to the HICAT database.

an applet, the HICAT database is able to return source data in VOTable format. This is done through use of a combination of VOTable-compliant Notes forms and Notes agents able to dynamically generate VOTable-compliant content. The VOTable 1.0 Document Type Definition is stored within the HICAT database as a Notes page, ensuring any VOTable validity checks are independent of external resources.

Both a general parameter comparison search and conesearch facility are provided in the HICAT database, and the database has been full-text indexed to optimise search operations performed on document fields containing non-numeric data. In Figure 2, a sample of VOTable source code returned from the search facility is given. The HICAT database responds to HTTP GET queries and returns results in VOTable format. An example of this type of query is

```
http://www.hicat.org/HICAT.nsf/HICAT?SearchView\&Query=FIELD+
VELOC>7000+AND+FIELD+ID\_NUMBER<5000,
```

where an *example domain name* has been used and a simple search based on general velocity and source id values has been sent.

It is proposed that future versions of the HICAT database reserve VOTable result sets for responses to remote HyperText Transfer Protocol (HTTP) GET data queries, and use eXtensible Stylesheet Language (XSL) to respond to all other data requests. A custom HICAT XSL stylesheet designed for use with VOTable content has been tested successfully in the HICAT database. This stylesheet presents data in a format meeting far more guidelines associated with rapid user comprehension of results (Shneiderman 1998) than raw VOTable formatting. The eXtensible Stylesheet Language: Transforms (XSLT) process that does this is shown in Figure 3.

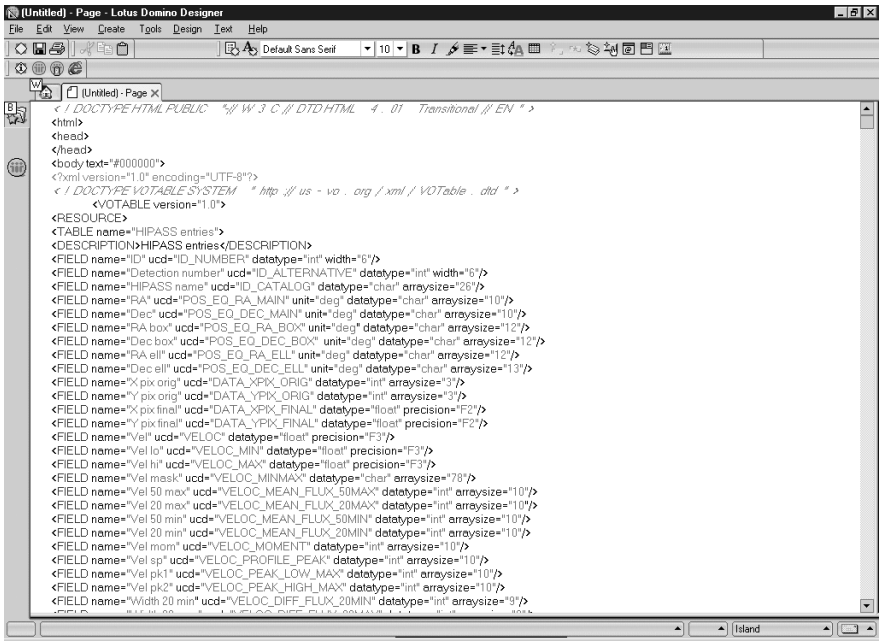

Figure 2. Sample VOTable document generated by the HICAT search facility.

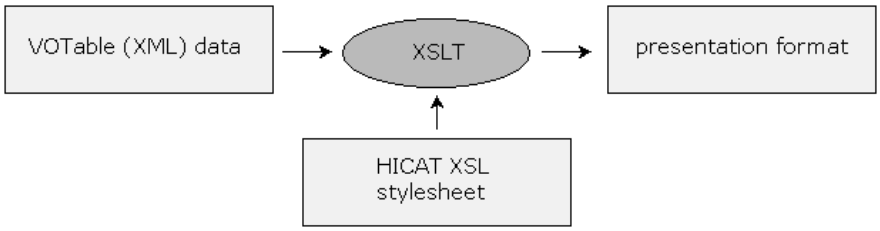

Figure 3. Improving data presentation through XSL transformation of VOTable content.

3. Dynamic User-Customisable Interface

The HICAT Virtual Observatory system uses a number of techniques to present its dynamic views and result sets. For example, Common Gateway Interface QUERY_STRING variable, general parameter and name-value pair (Hoey 2003) parameter passing, and LotusScript WebQueryOpen and WebQuerySave agents all feature. Manipulation of the Domino NotesView object is also employed — release 6 Domino databases allow read-write programmatic access to the IsHidden property of the NotesViewColumn class. We have taken advantage of this feature to reduce database size and design complexity by using a single database view, but allowed users effective access to this object property. Instead of including a series of general-purpose views in an effort to satisfy a wide range of users (Nolen 2001), every user may customize the HICAT view they see to their own needs by entering hide/display preferences on an Options form. The

WebQuerySave event of this form triggers a Notes agent that then toggles the visibility of columns in the HICAT view accordingly.

In addition to providing a Web-based interface to HICAT, the Domino HICAT database has provision for limited use by Lotus Notes 6 clients. Accessing the database through a Notes client gives access to every data element of every catalogue source and provides a facility for importing new data. Other miscellaneous HICAT database information and settings may also be reviewed from within the Notes client, such as database size, number of documents, access history, *et cetera*. In the interest of user interface consistency between browser and Notes client interfaces, selected Web forms have been emulated with Notes pages within the Notes client.

4. Grid Computing on Domino

Domino servers can be joined within a network into Domino Internet Clusters to provide a series of native Grid computing features, such as distributed computing, high-availability and high-performance computing, and user- and database-level security (see eg. Hardenburgh 2002; Kirkland 2000; Lamb & Lew 1999). Domino also provides native cluster management features, a cluster analysis tool in Domino Administrator, recording of cluster activities in the Domino Server Log and additional cluster configuration details in its Cluster Database Directory (Hardenburgh 2003). The HICAT Virtual Observatory service database is currently available to be deployed as a series of replicas on such a cluster.

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