TAP Service Federation Factory
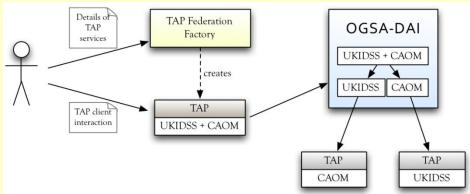
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Introduction

Querying distributed datasets has been a long held but elusive goal of the International Virtual Observatory Alliance (IVOA). Difficulties include designing a service infrastructure that can handle the necessary tasks of metadata federation, data access and query planning across an arbitrary set of independent data sources. We have now built a service that accomplishes this utilizing the IVOA Table Access Protocol (TAP) [1] in conjunction with the database oriented grid middleware OGSA-DAI[2].

TAP Federation Factory

The TAP Federation Factory[3] utilises a three layer architecture to provide data access to an arbitrary collection of TAP services. Users submit a list of TAP endpoints along with their associated VOSI table metadata locations and the factory returns a TAP endpoint for a newly generated service that federates the requested datasets. Users can then query this new TAP service as they would any other, be it through command line software or GUI clients like Topcat[4].
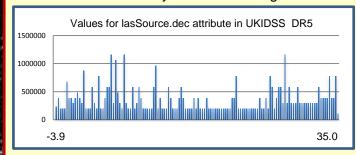

Three Layer Architecture
• **Top layer** – A RESTful web service visible to the user which creates the federated TAP endpoint from the user's request.
• **Second layer** – An OGSA-DAI server instance connected to the generated TAP endpoint through JDBC and to the federated datasets through TAP. OGSA-DAI contains a powerful distributed query processor (DQP) which handles the query planning and execution on the distributed data sources.
• **Third layer** – Any of the already existing TAP services in the VO. OGSA-DAI was extended to support ADQL queries to TAP services and is able to handle the resulting VOTable output for returning results to the user.

Use of Physical Metadata

In this example the histogram for the dec attribute of the UKIDSS lasSource table (shown below) allows the query planner to determine the dec range that can overlap with the CAOM data and hence insert clauses into the query sent to CAOM to ensure only data in this range is returned.

This optimization can be seen in the query plan as the bold text within the CAOM Table Scan box to the right.

Future Development

Our ultimate goal is to deploy a registered TAP Federation Factory Service for open use by the astronomical research community. It will be accessible through a Web 2.0 interface as well as through standard HTTP messages. The current service will be ready for this after a period of final testing and community consultation.

In the meantime we are working on improving the join algorithm choice and execution through use of physical metadata, support for ADQL spatial functionality, improved performance for joins of large (multi terabyte) databases, and support for more join algorithms such as range joins and batch joins.

Issues and Complexities

A number of issues were identified with the underlying TAP services during development and testing of the TAP Federation Factory. Many of these are due to incomplete implementations of the TAP protocol and are expected to be dealt with as these services mature and their software is brought in line with the published spec. Some of these are currently being examined by the Data Access Layer working group of the IVOA.

• **Binary data transfer** – In order to reduce data transfer times our service would utilize the binary VOTable format, but at present not all TAP services support this, and furthermore there is no standard method for invoking it on those services where it is enabled
• **Metadata Access** – Currently our Factory service requires the user to supply metadata endpoints for each TAP service they wish to federate. This is due to a lack of TAP services capable of executing standard metadata queries.
• **Row restrictions** – Many TAP services restrict the number or rows that can be returned though this is not documented anywhere accessible.
• **Physical Metadata** – In order to construct efficient query plans our Factory service would benefit from having access to the physical metadata describing the values held in the database. With this statistical histogram information the federation solutions can make better cardinality estimates and henceforth more optimised decisions on join algorithms and query planning/execution. All DBMSs provide this information, but it will be necessary to standardise how and where this information will be published before our service could utilize it.
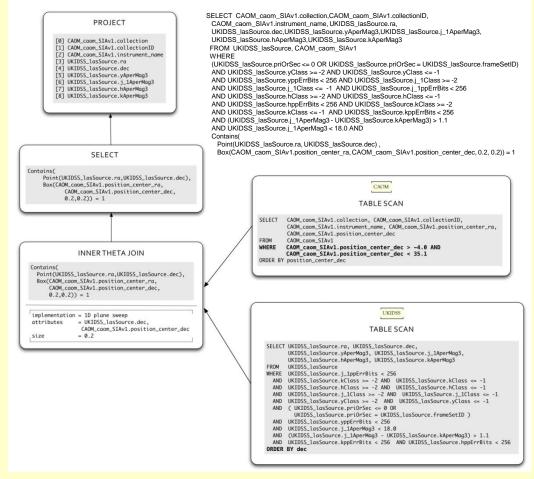
Example Query Execution

In this example query we are joining data from the Canadian Astronomy Data Centre's TAP service[5] with data from the UKIDSS Data Release 5 TAP service to discover information in both archives about objects in a portion of the sky. The query and resulting query plan are shown below.

Key points to note include:
• All possible WHERE clauses have been pushed to the TAP servers.
• A 1D plane sweep algorithm has been chosen for the join
• To use the plane sweep algorithm, "order by dec" clauses have been pushed to the queries sent to the TAP servers.

Query Plan

For More Details

Info on the software referenced above can be found at these sites:
[1]TAP - www.ivoa.net/Documents/TAP/
[2]OGSA-DAI - www.ogsadai.org.uk
[3]TAP Federation Factory - www.ogsadai.org.uk/demos/astro/
[4]Topcat - www.star.bris.ac.uk/~mbt/topcat/
[5]CADC - cadcwww.dao.nrc.ca/cvo/

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