O7.9 Development of Japanese Virtual Observatory (JVO): Experience on Interoperation with other Virtual Observatories and its Future Plan

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Data Resources in NAOJ

- Subaru 8.2m Optical-Infrared Telescope
- Kiso 105cm Schmidt Camera
- Okayama 188cm Optical Telescope
- Nobeyama 45m Radio Telescope
- Nobeyama Millimeter Array
- Nobeyama Radioheliograph
- VSOP
- VERA
- ALMA
Data Resources in JAXA/ISAS

- ASCA X-ray astronomy satellite
- YOHKO solar physics satellite
- Ginga X-ray astronomy satellite
- HALCA VLBI satellite
- Geotail geomagnetosphere satellite
- Akebono aurora observation satellite
- ASTRO-F Infrared satellite
- ASTRO-E2 X-ray satellite
- SOLAR-B
VO Projects in the world

- 17 countries and a region
- International Virtual Observatory Alliance (IVOA)
  Standards to interoperate VOs
- Japan – Language to access federated DB

http://www.ivoa.net/
Schematic diagram of JVO

- **User Interface**
  - Query Editor
  - VOTable viewer
  - DB queries
  - Plotter
  - etc

- **Controller**
  - parser
  - scheduler
  - Service caller

- **User DB**

- **Web Services**
  - Resource Meta-data
  - JVOQL (VOTable)
  - VOTable, FITS
  - SIAP/SSAP/SkyNode
  - etc

- **JVO Portal Server**

- **Input Queries and Analysis Parameters**

- **Registry (XMLDB)**

- **JVO Server**

- **US/CAN**

- **Europe**
Integration of standard protocols

**Table**
- column1
- column2
- ...

**Interface to the VO world**

**ADQL**

**VO Table**

**Converter**

**Formatter**

**SkyNode Controller**

**Result Set**

**SQL for backend DB**

**A collection of tables actually queried.**

**Fig.1 JVO SkyNode architecture.**
Exchange of Meta Data: OAI-PMH

- Searchable Registry
- Publishing Registry
- Query Services
- Access to various services
- Data Service
- Analysis Service
- Virtual Observatory Client
Schematic diagram of JVO

JVO Portal Server

User Interface
- Query Editor
- VOTable viewer
- DB queries
- Plotter
- etc

Controller
- parser
- scheduler
- Service caller

User DB

Web Services

Registry (XMLDB)

Input Queries and Analysis Parameters

Resource Meta-data

XML

XPath

JVOQL (VOTable)

JVO Server

Web Services

Server 1

Catalog DB

Meta DB

FITS

Server 2

Catalog DB

FITS

Server 3

Catalog DB

FITS

VOTable, FITS

SIAP/SSAP/SkyNode

SIAP/SSAP/SkyNode

XML etc.

US/CAN

Europe

US/CAN

Europe

JVO Portal Server
Interconnected VOs in the World
Successful Interoperations

- Accesses from / to other VOs in Europe and US have been available since Dec 2004
- Publishing & Searchable Registries
- 117 resources are accessible as of today
Elapsed time to querying US VOs

<table>
<thead>
<tr>
<th>wavelength</th>
<th>Survey name</th>
<th>server</th>
<th>time (sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>X-ray</td>
<td>Chandra</td>
<td>cda.harvard.edu</td>
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</tr>
<tr>
<td>Infrared</td>
<td>2MASS</td>
<td>mercury.cacr.caltech.edu</td>
<td>3.536</td>
</tr>
<tr>
<td>Radio</td>
<td>VLA</td>
<td>adil.ncsa.uiuc.edu</td>
<td>7.115</td>
</tr>
</tbody>
</table>

Best Records -- Some servers may be overloaded from time to time
JVO is seen from the UK VO

<table>
<thead>
<tr>
<th>Title</th>
<th>Type</th>
<th>AuthorityID</th>
<th>ResourceKey</th>
<th>Updated</th>
</tr>
</thead>
<tbody>
<tr>
<td>JVO Publishing Registry</td>
<td>vg:Registry</td>
<td>o</td>
<td>publishingregistry</td>
<td>200-16</td>
</tr>
<tr>
<td>JVO Publishing Registry</td>
<td>vg:Registry</td>
<td>jvo</td>
<td>publishingregistry</td>
<td>200-21</td>
</tr>
<tr>
<td>the Subaru/XMM-Newton Deep Survey (SXDS)</td>
<td>sn:OpenSkyNode</td>
<td>jvo/skynode</td>
<td>sxds</td>
<td>200-20</td>
</tr>
<tr>
<td>SkyNode Service</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>the Subaru/XMM-Newton Deep Survey 01</td>
<td>jsn:OpenSkyNode</td>
<td>jvo/skynodej</td>
<td>sxds</td>
<td>200-20</td>
</tr>
<tr>
<td>JVO</td>
<td>vr:Organisation</td>
<td>jvo</td>
<td>jvo</td>
<td>200-18</td>
</tr>
<tr>
<td>the Subaru/XMM-Newton Deep Survey (SXDS)</td>
<td>sia:SimpleImageAccess</td>
<td>jvo/siap</td>
<td>sxds</td>
<td>200-20</td>
</tr>
<tr>
<td>SIA Service</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>JVO Authority</td>
<td>vg:Authority</td>
<td>jvo</td>
<td>null?!!</td>
<td>200-21</td>
</tr>
</tbody>
</table>
QSO searches

Such results can be obtained only in a few minutes
Performance Improvement

- Memory consumption was too large.
- AXIS implementation
- Introduced memory garbage → stable operation

Visit P.105 : Shirasaki et al. for details
Future Prospects

• Started to design / implement operational system
  – More User-friendly interfaces
  – Add analysis engines by Java-wrapping
  – Single-Sign-on, authentication by Grid tool
  – Download to / Upload from user machines
  – Science corresponding to use cases !!
  – Design workflows

• Experimental operation – March 2006 (hopefully)
• Technologies sharing in AP region (East Asia)
Workflow Description Language

Based on BPEL4WS

- Variable definition
- Controls (Loop, Condition)
- Parallel execution
- Invoke external services
- Invoke built-in Java Classes

Visit P.107 : Tanaka et al. for details
# JVO collaborators

## Project Scientists
**NAOJ**
- Mizumoto
- Oe
- Shirasaki
- Tanaka
- Honda
- Kawanomoto

**ICRR**
- Yasuda

**Ochanomizu U.**
- Masunaga

## System Engineers
**Fujitsu Ltd.**
- Monzen
- Kawarai
- Ishihara
- Tsutsumi

**SEC Ltd.**
- Morita
- Nakamoto
- Kobayashi
- Yoshida

## Supporter
**NII**
- Miura

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ADASS2005 @ El Escorial, Spain
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• NAOJ
  – funding, personnel, etc.
Reference URLs

JVO – http://jvo.nao.ac.jp/index-e.html
IVOA – http://www.ivoa.net/

there are links to other VO projects in the world
Too hard to collect and analyze whole data. Need Cat’s help

Accelerate astronomical research, and sufficient time for research itself !!

Virtual Observatory

Data Rate

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Nobeyam Radio Obs.</td>
<td>~ 1 TB/yr</td>
</tr>
<tr>
<td>SUBARU telescope</td>
<td>~ 20 TB/yr</td>
</tr>
<tr>
<td>ALMA</td>
<td>~ 1 PB/yr</td>
</tr>
</tbody>
</table>

Even for educational use

Accessible from anywhere at any time
What is the Virtual Observatory…
and what it is not…

The VO is:

• A set of international standards to share complex data
• A modular set of tools to work with distributed data
• A simple environment to publish data to
• An essential part of the research astronomer’s toolkit
• A catalyst for world-wide access to astronomical archives
• A vehicle for education and public outreach

The VO is not:

• A replacement for building new telescopes and instruments
• A centralized repository for data
• A data quality enforcement organization
Standardization in IVOA

- **Query language** to distributed DBs (VOQL)
- **Meta-data**: contents, protocol to interchange based on OAI-PMH
- Protocols to retrieve images, spectra, and so on. SkyNode, SIAP, SSAP, STC, etc.
- Unified attribute names in DBs **UCD** (Unified Contents Descriptions)
- **Output Format**: VOTable (XML) incorporates FITS
- etc
International Endorsements

- IAU XXVth GA Res. (2003 Jul.)
- OECD Rec. (‘04 Aug)
  - place archives that may be accessible via internet
  - provide adequate funding as long-term issues
DBs available under JVO

- Subaru SupCAM (partial)
- SXDS
- SMOKA (catalog)
- SDSS – images/spectra
- 2MASS
- JAXA/ISAS – ASCA
  - More to come
Analysis Tools

• **Sextractor** – extract source parameters
generate personal catalogs

• **HyperZ** – derive photometric Z

• **Aladin** – Image viewer

• **VOPlot** – Plot VOTables

• **SpecView** – Spectral Energy Distribution
generator

• More to be added
  – Legacy softwares, Data mining, personal DBs, etc.