PPARC

A PPARC funded project

AstroGrid

Astro Runtime as an Application Interface

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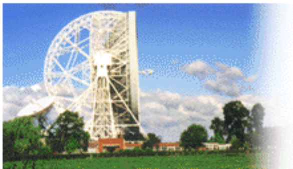

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The University of Manchester
University of Portsmouth
Queen's University Belfast
UCL MSSL
AstroGrid
The University of Manchester

AstroGrid

- A nearly complete Virtual Observatory (VO) system
- http://software.astrogrid.org
- Built upon Web Services – callable via SOAP
- Conforms to international (IVOA) standards where defined, elsewhere proposes new standards
- Useful for real research
- Security -final part that needs to be done.
  - Authentication & Authorisation
- The presentation shows how AstroGrid provides access to remote applications and data collections – the underpinnings of workflow.

Registry

- A hierarchical database (XML).
- Contains records that describe
  - data collections (coverage, catalogue structure, access methods)
  - remote applications (purpose, parameters, invocation methods)
  - supporting web services – storage, security, etc
  - other useful resources – e.g. client-side applications, organizations.
- Accessed by Web Service
- Query using XQuery, Keywords, or ADQL
- Used to locate (resolve) all other VO Web Services
- Exchanges records with registries in other VO projects (harvesting)

Myspace

- Distributed, location transparent, file storage
  - Each user has a single folder hierarchy – maintained by a *filemanager* service
  - Files in the hierarchy may be stored at different locations – each location is a *filestore*
  - clients typically interact only with the filemanager.
- AstroGrid services can read / write to Myspace
  - Place to stage results of long-running queries & computations
  - Used as a buffer for intermediate products of workflows
- Enables data to be kept near processing tools
- Being standardized in IVOA as VOSpace / VOStore

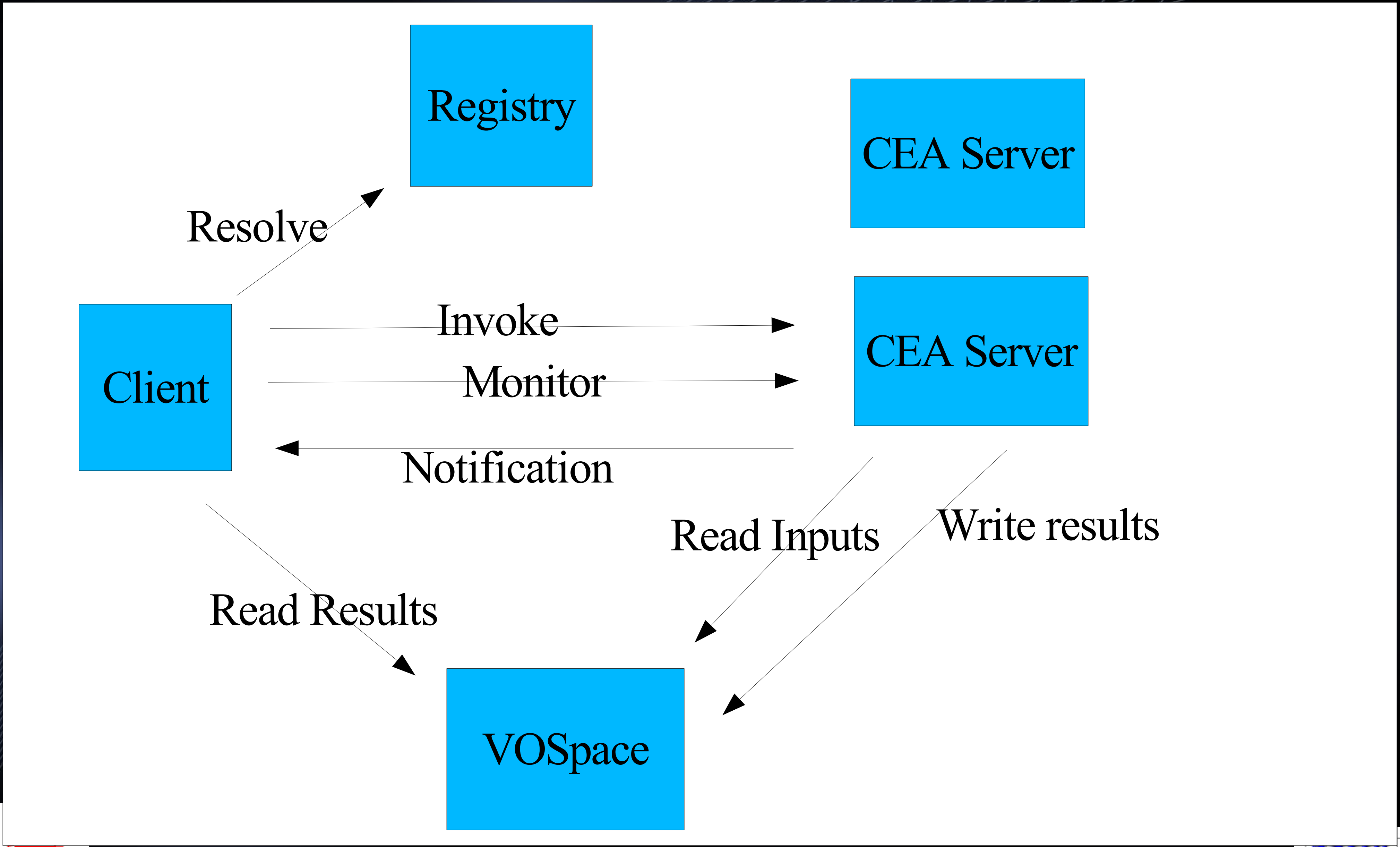
Remote Applications

- Common Execution Architecture - CEA
- Uniform method of describing and providing access to remote applications. Encompasses:
  - dataset access (e.g. Querying a catalogue database or image collection)
  - data processing – by VO-enabling popular legacy codes (e.g. X-matching, source extraction, simulations)
- CEA applications can be invoked from client scripts, UI, and server-side workflows
- Working System, with installed base.
- Described in IVOA Note
- Next generation IVOA proposal 'Universal Worker Service'

CEA Servers

- A CEA Server may provide one or more applications
- Asynchronous invocation
  - CEA server provides progress monitoring, notifications, and control
  - results can be retrieved from the service, or staged to myspace, ftp server, etc.
  - All interfaces are standard web services.
- Servers, and the applications they provide, are described in the registry.
- Clients can query registry to find applications, and servers that provide them.
- Applications can be replicated across multiple servers, for fault-tolerance.

Execution schematic



Installed Base - 2006-05-10

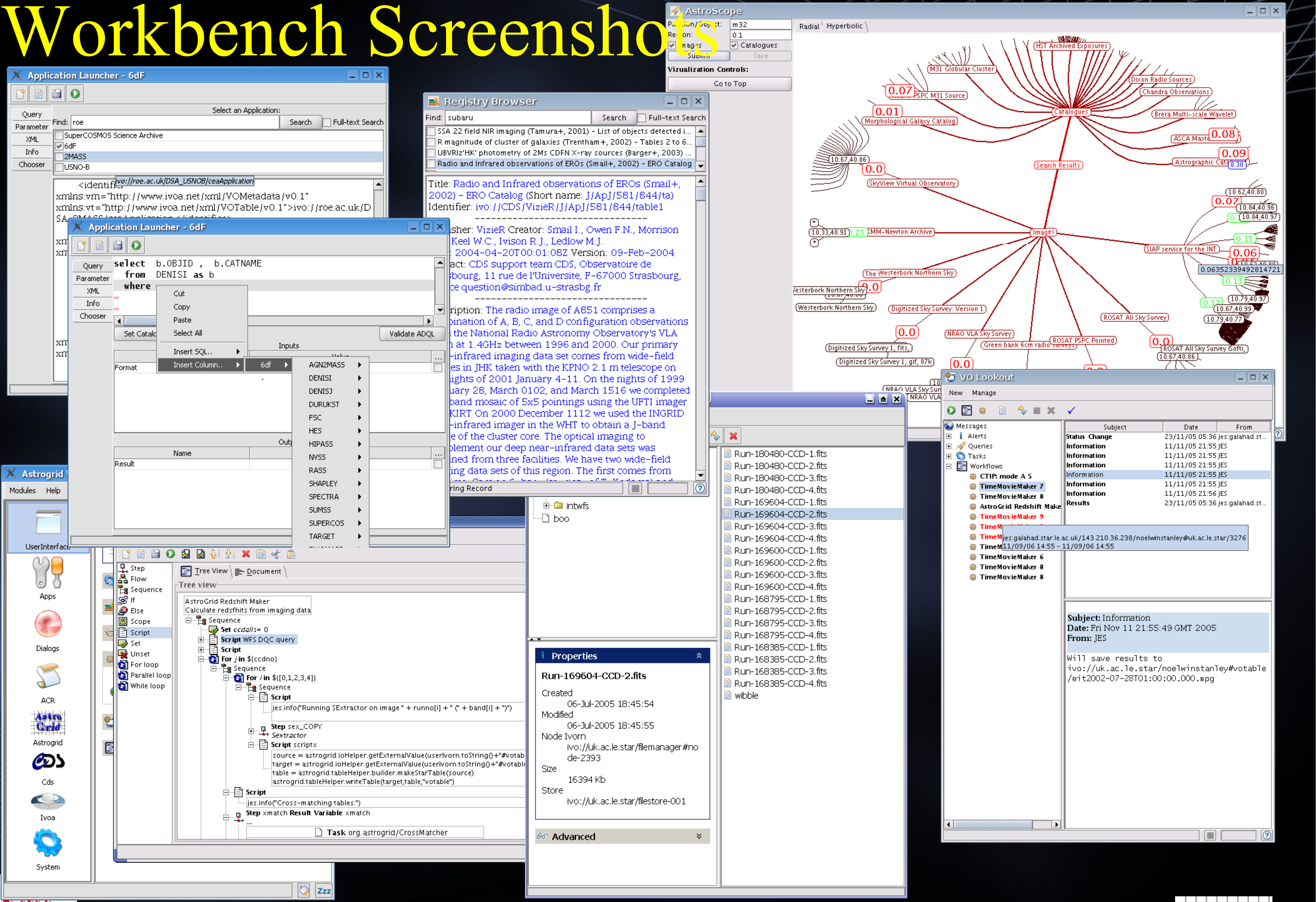
- 50 CEA servers,
  - UK – portsmouth, ral, mssl, edinburgh, cambridge, leiecester, jodrell
  - France, Russia,
- 70 applications available
  - Datasets – FIRST, INT-WFS, Ledas, SDSS,
  - Images – GOODS, HST-UDF, SDSS, XMM, Merlin
  - Existing Astro Apps – Sextractor, HyperZ, Galaxev, Pegase, BPZ, ACE, SWarp
  - New Apps – solar movie maker
  - General purpose – GNUPlot, R,

Accessing AstroGrid Services

User Perspecticve

- Two alternative user interfaces
- Portal – a web interface, accessed through browser
  - handy for occasional use
  - technical limitations of the web (pre-AJAX) make it awkward for advanced tasks
- Workbench – GUI client
  - Java WebStart Application
  - rich user applications
    - data discovery – astroscope & helioscope
    - application launcher – run a single CEA application
    - workflow builder – combine CEA applications
    - myspace browser
  - scripting access to VO
  - PLASTIC Hub – data exchange with Topcat, Aladin, Vospec, Visivo

Workbench Screenshots



```
select  b.OBJID ,  b.CATNAME
  from  DENISI as b
 where
```

<identifi ivo://roe.ac.uk/DSA_USNOB/ceaApplication
xmlns:vm="http://www.ivoa.net/xml/VOMetadata/v0.1"
xmlns:vt="http://www.ivoa.net/xml/VOTable/v0.1">ivo://roe.ac.uk/D

- SSA 22 field NIR imaging (Tamura+, 2001) - List of objects detected i...
- R magnitude of clusters of galaxies (Trentham+, 2002) - Tables 2 to 6...
- UBVRIz'HK' photometry of 2Ms CDFN X-ray sources (Barger+, 2003) ...
- Radio and Infrared observations of EROs (Smail+, 2002) - ERO Catalog

Title: Radio and Infrared observations of EROs (Smail+, 2002) - ERO Catalog (Short name: J/ApJ/581/844/ta)
Identifier: ivo://CDS/VizieR/J/ApJ/581/844/table1

Publisher: VizieR Creator: Smail I., Owen F.N., Morrison ... Keel W.C., Ivison R.J., Ledlow M.J. ... 2004-04-20T00:01:08Z Version: 09-Feb-2004 ... Contact: CDS support team CDS, Observatoire de Strasbourg, 11 rue de l'Universite, F-67000 Strasbourg, ... question@simbad.u-strasbg.fr

Description: The radio image of A851 comprises a combination of A, B, C, and D configuration observations ... the National Radio Astronomy Observatory's VLA ... at 1.4GHz between 1996 and 2000. Our primary ... near-infrared imaging data set comes from wide-field ... images in JHK taken with the KPNO 2.1 m telescope on ... nights of 2001 January 4-11. On the nights of 1999 ... January 28, March 0102, and March 1516 we completed ... a J-band mosaic of 5x5 pointings using the UFTI imager ... UKIRT On 2000 December 1112 we used the INGRID ... near-infrared imager in the WHT to obtain a J-band ... image of the cluster core. The optical imaging to ... complement our deep near-infrared data sets was ... obtained from three facilities. We have two wide-field ... imaging data sets of this region. The first comes from

```
AstroGrid Redshift Maker
Calculate redsfhits from imaging data
Sequence
  Set ccdall := 0
  Script WFS DQC query
  Script
  For j in ${ccdno}
    Sequence
      For i in ${[0,1,2,3,4]}
        Sequence
          Script
            jes.info("Running SExtractor on image" + runno[i] + " (" + band[i] + ")")
          Step sex_COPY
            Sextractor
          Script scriptx
            source = astrogrid.ioHelper.getExternalValue(userIvorn.toString()+"#votab
            target = astrogrid.ioHelper.getExternalValue(userIvorn.toString()+"#votabl
            table = astrogrid.tableHelper.builder.makeStarTable(source)
            astrogrid.tableHelper.writeTable(target,table,"votable")
    Script
      jes.info("Cross-matching tables.")
    Step xmatch Result Variable xmatch
      ...
      Task org.astrogrid/CrossMatcher
```

- Run-180480-CCD-1.fits
- Run-180480-CCD-2.fits
- Run-180480-CCD-3.fits
- Run-180480-CCD-4.fits
- Run-169604-CCD-1.fits
- Run-169604-CCD-2.fits
- Run-169604-CCD-3.fits
- Run-169604-CCD-4.fits
- Run-169600-CCD-1.fits
- Run-169600-CCD-2.fits
- Run-169600-CCD-3.fits
- Run-169600-CCD-4.fits
- Run-168795-CCD-1.fits
- Run-168795-CCD-2.fits
- Run-168795-CCD-3.fits
- Run-168795-CCD-4.fits
- Run-168385-CCD-1.fits
- Run-168385-CCD-2.fits
- Run-168385-CCD-3.fits
- Run-168385-CCD-4.fits
- wibble

Run-169604-CCD-2.fits
Created
06-Jul-2005 18:45:54
Modified
06-Jul-2005 18:45:55
Node Ivorn
ivo://uk.ac.le.star/filemanager#node-2393
Size
16394 Kb
Store
ivo://uk.ac.le.star/filestore-001

Subject	Date	From
Status Change	23/11/05 05:36	jes:galahad.st...
Information	11/11/05 21:55	JES
Information	11/11/05 21:55	JES
Information	11/11/05 21:55	JES
Information	11/11/05 21:55	JES
Information	11/11/05 21:55	JES
Information	11/11/05 21:56	JES
Results	23/11/05 05:36	jes:galahad.st...

jes:galahad.star.le.ac.uk/143.210.36.238/noelwinstanley@uk.ac.le.star/3276
11/09/06 14:55 - 11/09/06 14:55

Subject: Information
Date: Fri Nov 11 21:55:49 GMT 2005
From: JES

```
Will save results to
ivo://uk.ac.le.star/noelwinstanley#votable
/eit2002-07-28T01:00:00.000.mpg
```

THE UNIVERSITY of MANCHESTER

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Developer / Expert Perspective

- Three Alternatives
  - Call SOAP services directly, using WSDL
    - most basic – exposed to most complexity, necessary to understand services interact (e.g. resolution)
    - security – can require advanced SOAP handling.
  - Call AstroGrid delegate libraries
    - hides some complexity,
    - maybe not the cleanest or most reusable interface – developed for internal use.
    - Java-only – requires whole AstroGrid library stack
  - Use the Astro Runtime (AR)
    - Uniform facade interface to the VO.
    - Simpler to learn & provides extra functionality
    - Language Neutral

Astro Runtime (AR)

- A common facade library for virtual observatory services
  - aim to integrate all IVOA standards, popular ad-hoc services, and suitable helper functions.
- uniform abstraction level and types
  - cleaner API, less special cases, lower learning curve
- Shared component – single signon, configuration, cached registry entries, file trees
- Deployment alternatives
  - Webstartable desktop service / embeddable library / stand-along application
  - Workbench is implemented upon AR – an AR instance is available to other clients when Workbench is running.

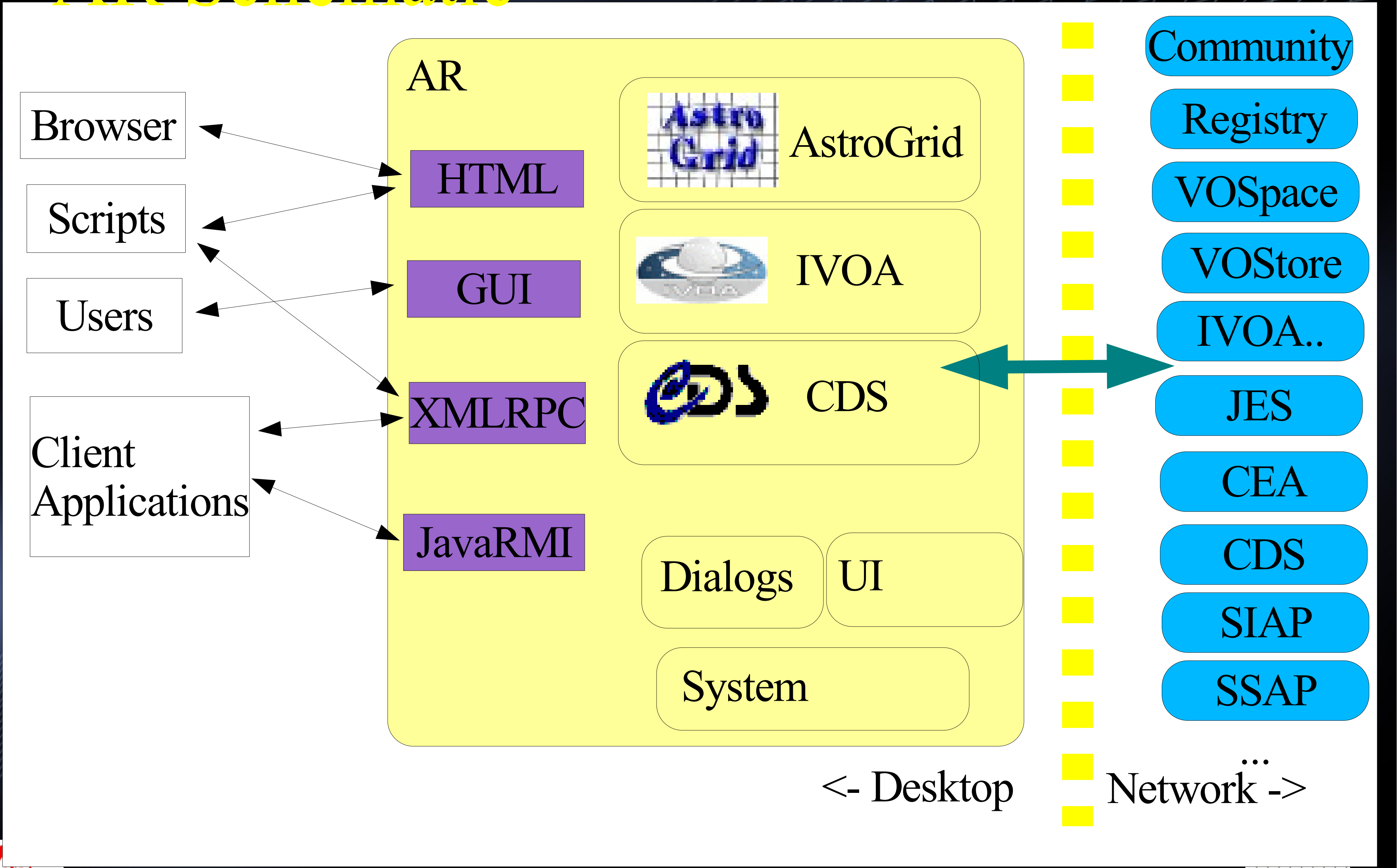
Design

- AR designed to be accessible from all programming languages
- Procedural design, rather than OO (astronomer friendly)
- Typical configuration - a service that runs on a user's desktop
    - accepts requests from other desktop applications
    - processes requests by calling webservices using the AstroGrid Java client libraries.
- Can also be embedded in a service implementation and called directly.

Access Methods

- At present, 3 ways to access AR functionality.
- JavaRMI (Java, Groovy, Jython)
  - JVM-only inter-process communication
  - strongly typed
  - requires a minimal set of libraries
  - allows remote event listeners to be registered
- XMLRPC (Python, Perl, C++, C# , Java)
  - Forerunner of SOAP: http://www.xmlrpc.com/
  - simpler types than SOAP
  - implementations for a wide range of languages
- HTTP-Get (Shell, R, IDL, Matlab)
  - rough-n-ready procedure call
  - fallback for other languages

AR Schematic



AR Abilities

- AstroGrid
  - CEA: query, build, execute, monitor
  - Workflow – submit, monitor.
  - MySpace: read, write, list, create, delete
  - Registry: query, xquery, resolve
- IVOA – SIAP, SSAP; SkyNode to follow.
- CDS – Simbad, Vizier, coordinates, UCD.
- NVO – cone; NED, other ad-hoc to follow
- PLASTIC – send data to other client-side applications
- UI - control workbench user interface, display dialogues to prompt for input

Connecting to AR - Code

Don't Panic!

Java: RMI

Import AR classes

Instantiate finder

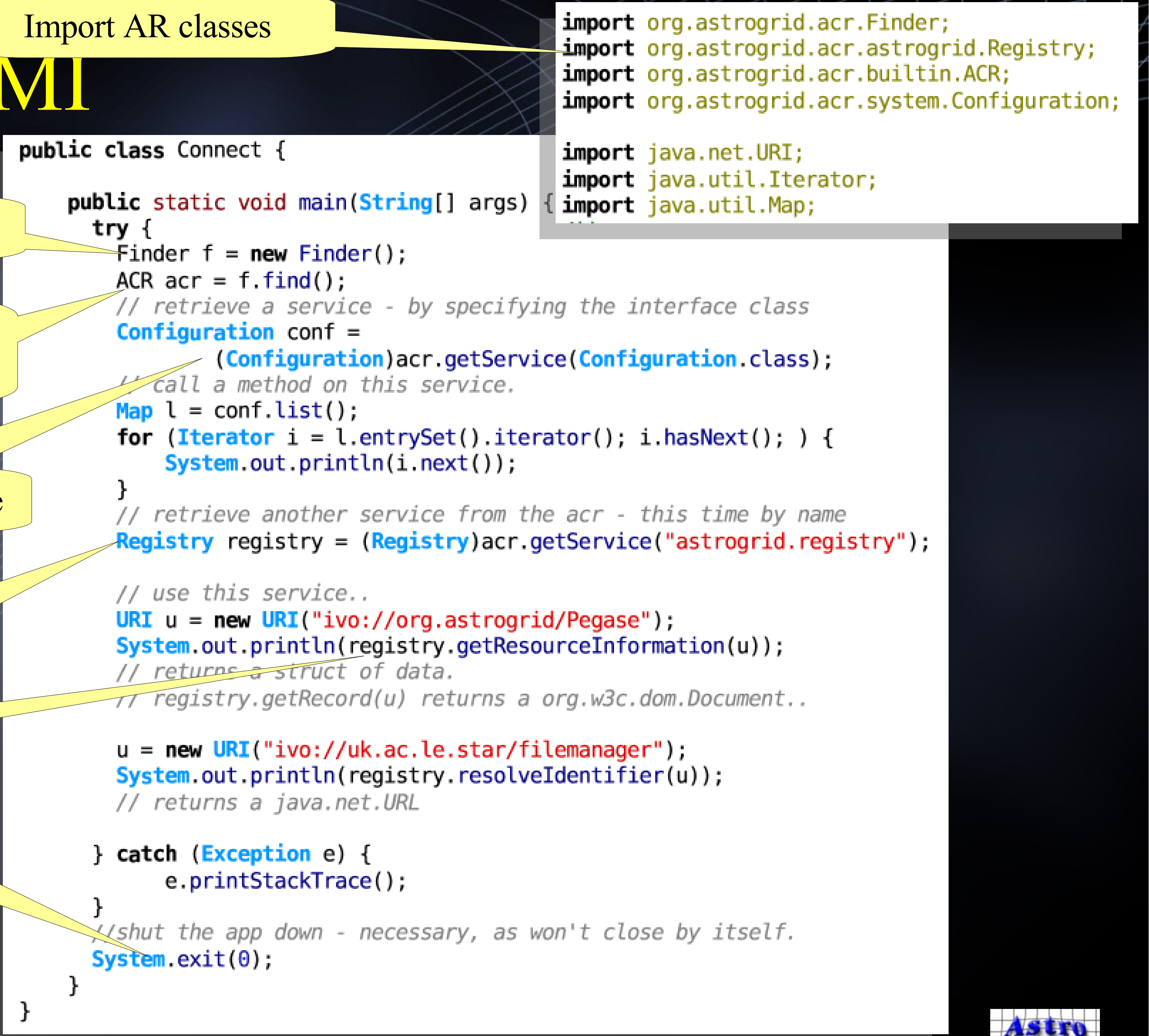
Find running AR, or execute new

Get reference to service

Alternative way to get service

Call service function

Tell program to exit



```
import org.astrogrid.acr.Finder;
import org.astrogrid.acr.astrogrid.Registry;
import org.astrogrid.acr.builtin.ACR;
import org.astrogrid.acr.system.Configuration;

import java.net.URI;
import java.util.Iterator;
import java.util.Map;
```

```
public class Connect {

    public static void main(String[] args) {
      try {
        Finder f = new Finder();
        ACR acr = f.find();
        // retrieve a service - by specifying the interface class
        Configuration conf =
                (Configuration)acr.getService(Configuration.class);
        // call a method on this service.
        Map l = conf.list();
        for (Iterator i = l.entrySet().iterator(); i.hasNext(); ) {
            System.out.println(i.next());
        }
        // retrieve another service from the acr - this time by name
        Registry registry = (Registry)acr.getService("astrogrid.registry");

        // use this service..
        URI u = new URI("ivo://org.astrogrid/Pegase");
        System.out.println(registry.getResourceInformation(u));
        // returns a struct of data.
        // registry.getRecord(u) returns a org.w3c.dom.Document..

        u = new URI("ivo://uk.ac.le.star/filemanager");
        System.out.println(registry.resolveIdentifier(u));
        // returns a java.net.URL

      } catch (Exception e) {
            e.printStackTrace();
      }
      //shut the app down - necessary, as won't close by itself.
      System.exit(0);
    }
}
```

Python: XML-RPC

Import xmlrpc library

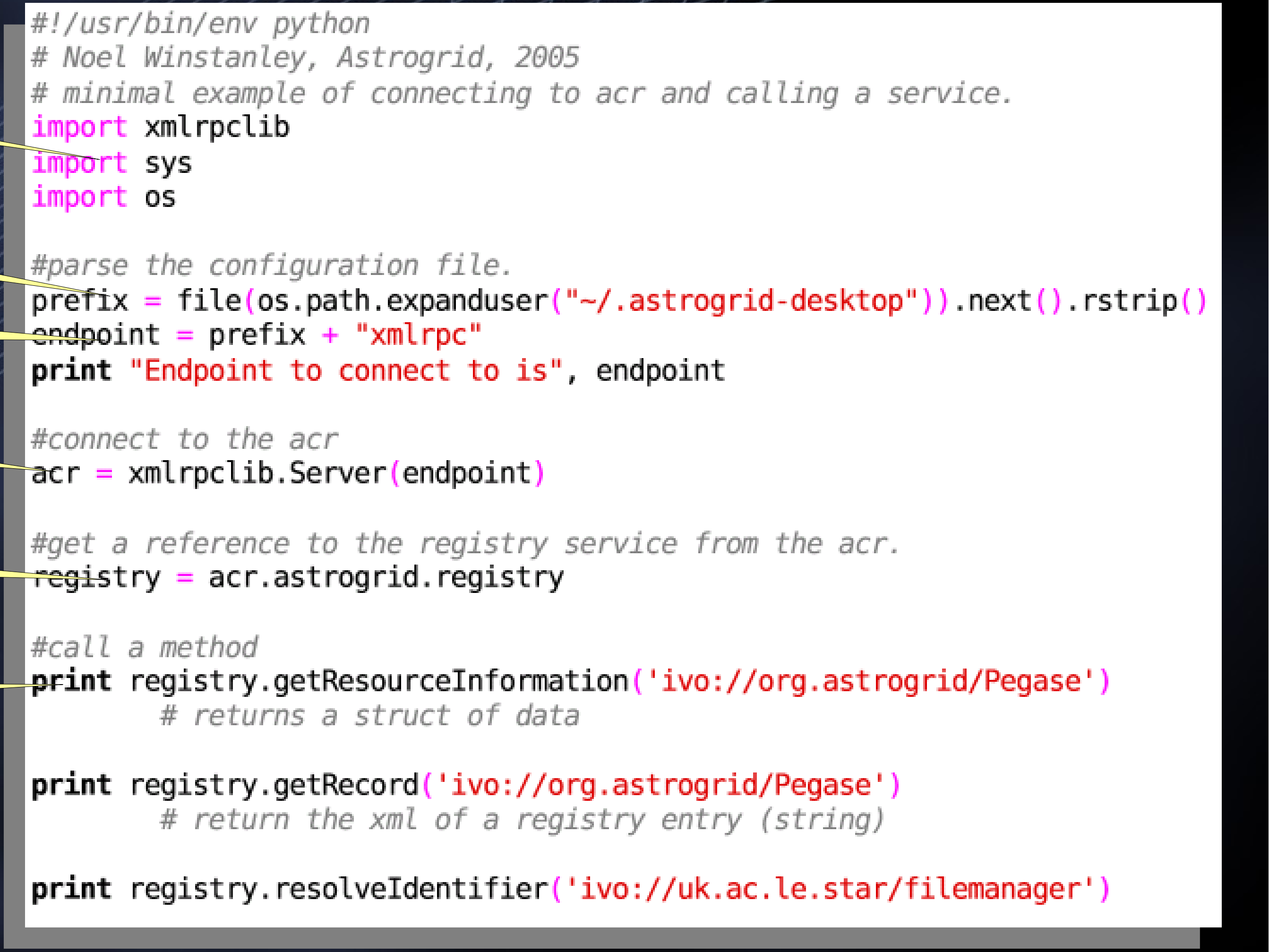
Read AR configuration file

Construct xmlrpc endpoint

Create client

Get reference to service

Call service function



```
#!/usr/bin/env python
# Noel Winstanley, Astrogrid, 2005
# minimal example of connecting to acr and calling a service.
import xmlrpclib
import sys
import os

#parse the configuration file.
prefix = file(os.path.expanduser("~/.astrogrid-desktop")).next().rstrip()
endpoint = prefix + "xmlrpc"
print "Endpoint to connect to is", endpoint

#connect to the acr
acr = xmlrpclib.Server(endpoint)

#get a reference to the registry service from the acr.
registry = acr.astrogrid.registry

#call a method
print registry.getResourceInformation('ivo://org.astrogrid/Pegase')
        # returns a struct of data

print registry.getRecord('ivo://org.astrogrid/Pegase')
        # return the xml of a registry entry (string)

print registry.resolveIdentifier('ivo://uk.ac.le.star/filemanager')
```

Uses for AR

- Environment for implementing VO Services
  - Workflow engines, VOEvent processors.
- VO-enable existing client-side applications
  - Topcat (.uk), Aladin (.fr), Visivo (.it), VoSpec (.es), ...
- New VO client-side Applications
  - AstroGrid Workbench, Sampo (.fi)
- Commandline utilities for VO
- Client-side Scripting (expert users) – (python, perl)
  - Script contains control flow
  - performs work by accessing CEA applications via AR
  - more interactive operation than batch Workflows
- Access VO in existing wrapper environments. - e.g.PyRaf, Parceltongue

Future Plans

- Will maintain backwards compatibility
- To add
  - missing service types - SkyNode
  - other ad-hoc astronomy webservices
  - VOTable, Xpath, XML helpers
  - make workbench UI components more controllable
- Track developing standards (VOSpace, SSO)
- Multi-session ACR for server-side deployment.
- Improve error reporting.
- Submit AR interfaces to IVOA in some way

References

- CEA
  - http://www.ivoa.net/Documents/latest/CEA.html
- Workbench Launch
  - http://software.astrogrid.org/userdocs/workbench.html
- AR Site – docs & download
  - http://software.astrogrid.org/beta/ar
- AR Wikipage
  - http://wiki.astrogrid.org/bin/view/Astrogrid/AstroClientRuntime
- Plastic
  - http://plastic.sourceforge.net