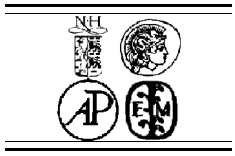

GumTree - An Integrated Scientific Experiment Environment

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Abstract

GumTree is an open source and multi-platform graphical user interface for performing neutron scattering and X-ray experiments. It handles the complete experiment life cycle from instrument calibration, data acquisition, and real time data analysis to results publication. The aim of the GumTree Project is to create a highly Integrated Scientific Experiment Environment (ISEE), allowing interconnectivity and data sharing between different distributed components such as motors, detectors, user proposal database and data analysis server. GumTree is being adapted to several instrument control server systems such as TANGO, EPICS and SICS, providing an easy-to-use front-end for users and simple-to-extend model for software developers. The design of GumTree is aimed to be reusable and configurable for any scientific instrument. GumTree will be adapted to six neutron beam instruments for the OPAL reactor at ANSTO. Other European institutes including ESRF, ILL and PSI have shown interest in using GumTree as their workbench for instrument control and data analysis.

Keywords: Java; Eclipse; Graphical User Interface; Control System; Data Analysis; EPICS; GRID; eResearch

1.Introduction

As part of the IT infrastructure for the Neutron Beam Instrument Project (NBIP) , the computing team at ANSTO is currently developing a novel application framework that will lead to the development of a next generation scientific workbench for performing experiments on any beamline. The GumTree project , named after a native flora in Australia, is aimed to provide a highly **Integrated Scientific Experiment Environment** (ISEE) for users to perform their experiment in their familiar experiment domain. GumTree serves three purposes:

- Client for instrument automation control and status / data acquisition
- Application for visualising live or offline data
- Workbench for data reduction and analysis

2.Integrated Scientific Experiment Environment

2.1.Grand Unified Model for eScience System

A large scale scientific instrument such as neutron scattering instrument, synchrotron beamline or telescope consists of distributed components controlling different aspects of experiments across a network. Components within an instrument ecosystem can be as simple as a two channel relay switch to something as complex as a data storage system or GRID enabled data analysis system. As the instrument ecosystem expands, interfacing components electronically can be difficult to manage. To address such problem, Götz and Hauser have suggested the Grand Unified Model (or simply GUM) to unify the components within the instrument's eScience system. The model states:

The control and analysis parts of a scientific experiment must be treated as part of one system with input and output being readily exchanged between all

parts of the system. There must be a single integrated graphical user interface from which all aspects of the control and analysis system can be accessed. There is a basic set of building blocks that all control and analysis systems should have. All building blocks should have a well defined interface.

2.2.Plug-in Architecture Approach

GumTree is currently the first scientific workbench that closely follows the principle of the GUM. Common control system and middleware for large experimental physics are supported in GumTree, including **EPICS** , **TANGO** and **SICS** . Since the instrument ecosystem can be very dynamic, GumTree is built on an extensible and re-configurable plug-in architecture to ensure different pieces are integrated nicely into the workbench. Different technologies can be added via plug-ins, without modifying the core of GumTree.

2.3.Scientific Workbench for Instrument Users

The GumTree workbench is designed to be user friendly and intuitive. It provides the following advantages to the instrument users while performing their experiments:

- Allowing data exchange between different file formats, devices, and systems within an instrument ecosystem.
- Integrating data acquisition and data analysis components provides instantaneous feedback on the quality of measurement data, hence it is possible to apply online correction during an experiment.
- Users can work in their familiar scientific domain, as essential experiment components are modeled in the workbench user interface
- Experiment lifecycle management and application crash recovery are supported in GumTree
- Some user accessibility features are integrated in the GumTree workbench, text-to-speech for example.
- Wizards, a powerful help system and step by step guidelines help novice users perform a standard experiment.

2.4.Integrated Tool for Facility Managers

Instrument scientists and facility managers may also benefit from the advantages of GumTree to manage their instruments. GumTree provides:

- A centralised workbench to access and configure all systems and devices via a device communication model
- The ability to configure the workbench so that only the relevant components from the instrument ecosystem are exposed to users
- Customisation for more sophisticated experiments
- GumTree targets a wide range of user groups, from expert instrument scientists to novice university students, without limiting the flexibility for an experienced user.
- Easy customisation to support foreign languages
- Support for several computer operating systems.

2.5.GUI Framework for Software Developers

GumTree closely follows framework design principles from software engineering. The base of GumTree is designed to be modular, reusable, and extensible. It provides the following benefits to graphical user interface (GUI) developers:

- A ready made GUI framework so developers can focus on other important programming tasks.
- Development tools, templates and programmer documentation are integrated with GumTree's primary Integrated Development Environment (Eclipse).

3.Leveraging Software Technologies

A good software library can encourage code reusability, reducing code maintenance, and leveraging other developers' effort at minimal cost. The GumTree project leverages many cutting edge software libraries to enhance its functionality:

- **Java** is a high level cross platform object orientated language, which has been widely used for the scientific community. Many Java based scientific applications can be used within GumTree.
- **Eclipse** is a universal tooling platform for software engineers . Recently Eclipse has been used as the front end for a number of scientific applications. NASA JPL and Los Alamos National Laboratory are using Eclipse for Mars mission planning and parallel data processing respectively.
- The following range of data acquisition, data format and visualisation tools is also supported in GumTree.

Table 1. Plug-ins for GumTree

Plug-in Type	Plug-ins
Control System	EPICS, TANGO, SICS
Data Format	NeXus, HDF, Excel CSV, XML
Visualisation Engine	OpenGL, ISAW, Ptplot, VTK
Miscellaneous	Microsoft Office and Media Player support

4.User Scenarios

The concept of GumTree is being examined across different countries:

- ***ANSTO- OPAL, Australia***

The main driving force behind the GumTree Project is the need of a common GUI for the neutron scattering instruments at OPAL. Targeted instruments are High Intensity Powder Diffractometer (Wombat), High Resolution Powder Diffractometer (Echidna), Triple Axis Spectrometer (Taipan), Residual Stress Diffractometer (Kowari), Neutron Reflectometer (Platypus), and Small Angle Neutron Scattering (Quokka). The Medium Resolution Powder Diffractometer (MRPD) in ANSTO's HIFAR reactor is being used for testing the alpha version of GumTree. The GumTree Platform is further extended and customized for NBIP, the library of extensions is called GumNIX (**Gum**Tree **N**eutron beam **I**nstrument e**X**tension). A common look and feel across instruments reduces the learning curve for users and increases productivity and beam time utilisation for those who may operate more than one instrument at the OPAL.

- ***The European Synchrotron Radiation Facility, France***

Fable is a framework for automating synchrotrons beamline experiments in materials science . This project is being developed by the staff of ID11 at the ESRF (France) and the Risø institute (Denmark). GumTree has been proposed as the front end workbench for the data analysis part of the Fable project.

- ***Paul Scherrer Institut, Switzerland***

PSI is considering GumTree as a command line terminal to interface with their control system sequencer (SICS)

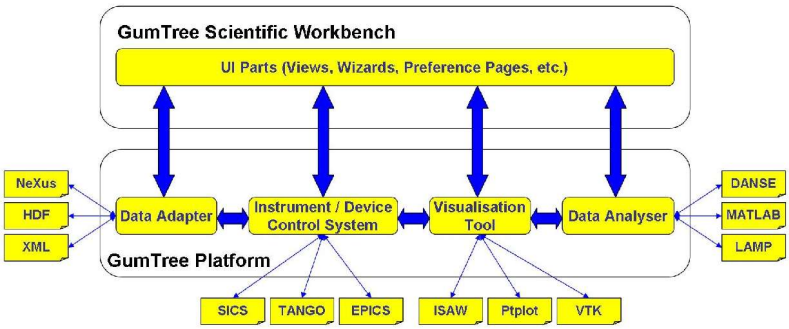

Figure 1 The GumTree Plug-in Architecture supports high degree of integration the workbench with various technologies from the area of data format, control system, visualization and data analysis.

- ***The Institut Laue Langevin, France***

Fame38 from ILL is currently adapting GumTree as the workbench for displaying residual stress data in 3D model via VTK graphics package. Fame38 has planned to adapt GumTree to their neutron residual stress, SALSA, for performing data acquisition and analysis under a single application.

5.Conclusion

GumTree is an open source project and it is a platform which encourages collaboration between different scientific institutions. Future plans for the GumTree project will involve GRID enabled data analysis support, and control system adaptation for CIMA, MAD and TACO.

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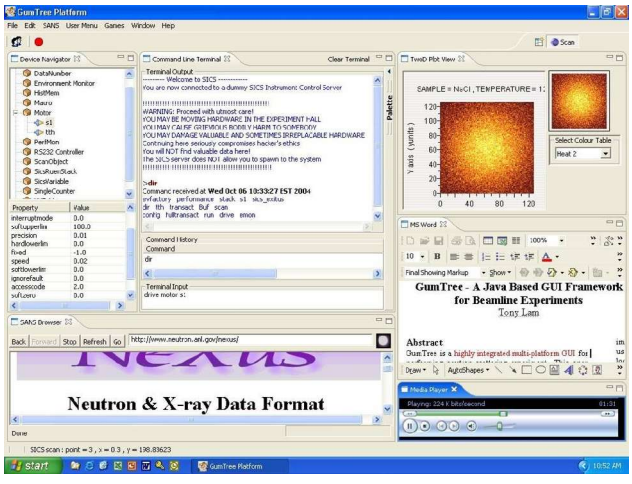

Figure 2 An integrated workbench (GumTree) with instrument control interface, device data visualization, web browser, word processor and media player