# Australian Synchrotron Project
# Beamline Control Systems User Workshop

**18,19 April 2005**

**Australian Synchrotron**
**800 Blackburn Road, Clayton**

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## 1 Background

A workshop was held at the Australian Synchrotron site to discuss a range of issues related to the beamline control systems. The workshop included people from the Australian Synchrotron Project, representatives of the user community and representatives from other similar research facilities. A part of the workshop was a combined session with the Beamline Advisory Group for presentation and discussion of Remote Access issues.

## 2 Objectives

The workshop was planned with the following objectives in mind:

- Convey current progress of machine control systems to users.
- Indicate current plans for beamline control systems to users.
- Present a range of user interface options to users.
- Commence process of collecting user requirements for control system/user interface.
- Describe existing network infrastructure and implications for beamline control systems.
- Gather input regarding user requirements for beamline network functionality.
- Create an opportunity for the users and the ASP controls staff to meet.

The workshop is intended to be an early part of the process of communication between the users and the Synchrotron controls staff. This process will continue through all stages of the beamline control system design, construction and commissioning.

## 3 Outcomes

The following is a summary of the outcomes of the user workshop. More detailed summaries of each aspect of the workshop follow later in this report.

- EPICS was presented as the primary choice for the beamline control system database layer. This choice is consistent with decisions made for the accelerator controls. It allows flexibility in design of user interface.
- There is a wide range of requirements for the user interfaces on the different beamlines. No single solution or technology will suit all beamlines. The control system for each beamline will be developed with the particular requirements of that beamline in mind, while still taking advantage of common areas where possible.
- Access to experimental data, both at the beamline and from a remote location, needs to be easy, fast and flexible.
- Security of the beamline control systems is important.
- Remote viewing and remote control of experiments is desirable.
- A range of policies on data storage and formats need to be established.
- Users need to have access to the outside world from the beamline user computers.
- Users will need to connect their personal computers to the facility network for data transfer, analysis and routine computer use.

## 4 The next steps...

The initial beamlines are either currently being tendered, or will be in the near future. EPICS will be the underlying control system specified for these beamlines. This decision is consistent with:

- the controls being developed for the accelerator;
- the approach being used for beamlines under construction at other facilities; and
- the feeling of those present at this workshop.

Given the differing requirements, the development of the user interface and data storage facilities for each beamline will be addressed individually. A formal software development process will be followed, which commences with defining the requirements for the system. This will involve ongoing consultation with the user community throughout the process.

User network access requirements will be captured and documented in a general beamline user requirement document. This will form the basis for the decisions made regarding network policy.

# 5 Presentation summary

Presentations were given in the following areas:

- beamline user interface systems,
- software development,
- personnel safety,
- remote access to experiments,
- network infrastructure,
- data storage, and
- detectors.

The intent of the presentations was to inform the audience of the technologies and options available and in use at other facilities, and to provide starting point for discussions in those areas. A full list of the presentations is contained in Appendix A.

The following sections contain a summary of the information contained in the presentations and the points raised in discussion in each of the above areas.

## 5.1 Beamline user interface systems

### 5.1.1 *EPICS*

- User interface should be intuitive for inexperienced users and fast and efficient for expert users. These requirements are often incompatible.
- Implementing EPICS at the lower level means that a range of user interfaces can be implemented, rather than being tied to a single interface technology.
- EPICS provides support for a wide range of devices that will be found on the beamlines, including motors, detectors.
- EPICS provides a series of in-built functions to perform common tasks on beamlines, including scanning, data save and restore.
- As much functionality as possible should be implemented in the server. This allows clients to be more interchangeable and lighter-weight.
- Where there is a choice of devices for a particular function, choosing a device with existing EPICS support reduces risk and development time. This can sometimes be offset by higher up-front cost.
- EPICS has support for fewer devices than LabVIEW. However, EPICS device support can be written that makes use of the LabVIEW device drivers.
- EPICS is capable of approximately 2kHz loop performance on vxWorks. Unsure what the performance would be on Linux due to its different interrupt handling performance.

### 5.1.2 *GumTree*

- GumTree (ANSTO interface for RRR) objective is to provide a consistent user interface across experiments.
- GumTree will integrate data analysis, data visualisation and experimental control in the same interface.
- GumTree is based on the Eclipse platform.
- GumTree does not currently provide support for EPICS, but this may change in the near future.
- Timeline is to have the basic functionality available in mid-2006.
- GumTree is extensible by developing plug-is that provide the required functionality.

### 5.1.3 *Protein Crystallography GUIs*

- Requirements include:
    - automatic crystal centering
    - logging of all changes on beamline
    - access to log via web browser
    - highly automated process
    - remote access
- Different styles of interface are available - graphical, tabular/text
- BluIce developed at SSRL does not natively interface with EPICS. There are two existing efforts to connect BluIce to EPICS: one at SSRL, the other at APS.
- PX beamlines often use robotic loading to improve throughput. The robot adds another layer of automation complexity, and requires additional support resources.

### 5.1.4 *Python, IDL and MEDM GUIs*

- Most beamlines at APS are Windows based.
- Exceed used to run X-Windows for MEDM.
- Automatically open front-end shutter when requirements are met in optics/experimental hutches.
- IDL as a tool for developing GUIs
    - object oriented, cross platform
    - powerful array operations
    - lots of visualisation functions
    - can distribute IDL graphic apps for free now that an IDL VM exists
    - IDL has powerful scripting capabilities
    - IDL can interface to ActiveX objects
- VB as a tool for developing GUIs
    - some detectors provide an ActiveX interface, allowing easy connection with VB
    - VB has limited supplied widgets

- Python as a tool for developing GUIs
    - free
    - used at a number of sites, so can re-use software
    - some issues with support of graphical libraries
- good scripting capabilities

### 5.1.5 *LabVIEW*

- Relatively expensive
- Extensive device support provided
- Range of options for interfacing LabVIEW to EPICS
- Does not inherently provide security. Relies on lower layer (e.g. EPICS) to do this.
- Change management can be implemented using Perforce.
- Easy implementation of remote access.

## 5.2 Personnel Safety System

- If shutters are open and a PSS event occurs, the RF should be dumped.
- We will implement a search process similar to other facilities.
- We need to resolve issues around the use and meaning of red and green on displays and panels.
- Facility to allow automatic opening of front-end shutters when all requirements are met is useful. This reduces the likelihood of user error, and streamlines beamline operation when injection occurs or the front-end shutters are closed for other reasons.

## 5.3 Remote access

### 5.3.1 *Marysville Remote Access Workshop*

- Remote access take-up relies on the simplicity and transparency of the interface.
- Options include:
    - remote desktop;
    - purpose built interface; and
    - web browser.
- Security is an issue when providing remote access.

### 5.3.2

### 5.3.3 *Remote access to instruments and data at OPAL*

- Different roles are supported by instrument server (view only, user, expert)
- Authentication provided using LDAP
- Client has significant functionality
- Robotics are not planned at ANSTO. Experiments are relatively slow, so automation does not add much value.
- User requirements for remote access include sample visualisation and indication of consistency between client data and experiment state.

### 5.3.4 *CSIRO Microscopy Telepresence*

- Provide shrink-wrapped software
- Generic interface to a range of instruments.
- Aims for minimal hardware requirements.
- Allows for high performance and good security implementation.
- High development overheads.
- Extensive use of cameras to convey information to remote users.
- Video links are two way to allow users to feed back information to local operator.
- Encryption places high demands on client computer when transmitting video.
- See approximately 5% use of remote access facility.
- CSIRO will not buy instruments if device driver libraries are not available.

### 5.3.5 *Grid-Enabling*

- Data security comprises three aspects:
  - access control;
  - integrity; and
  - durability.
- There is a need to capture experiment metadata and link it to the experimental data itself.

## 5.4 Network infrastructure

- Physical networks are more trusted than the wireless network.
- Users at APS all connect via wireless network. They are not allowed to plug into the wired network.
- APS wireless network is wide open. Users need to SSH/VPN to get to beamline controls/data.
- SLAC is similar to above. They also provide physical ports on the guest network, but this also requires SSH/VPN to get to beamlines.
- System needs to be simple to connect to and use.
- Some beamlines will generate and transfer many GB of data per day.
- Beamline computers need to have Internet access. This is a vital tool in the experimental process.
- Users will want to be able to connect their own computers to the network.
- There is a big drive for remote access/control of experiments.
- Beamlines at APS have their own web/FTP/SSH servers.
- Virus checking is important on all beamline computers.
- The option exists to split each beamline into more than one VLAN, and have different access restrictions to each.
- The network infrastructure at the Australian Synchrotron allows for flexibility in the logical network design.
- We need to resolve the data storage requirements for each beamline (volume, time) and determine if a centralised store is appropriate or if storage should be at each beamline. A mixture of these two solutions may also be appropriate.
- Off-site backup, storage and archiving of data needs to be investigated. Not sure at this stage of the statutory requirements for this.
- User computers only connect to guest network at ANSTO.
- ANSTO provides a standalone PC for checking virus definitions on user PCs.
- There will be a need to access computing clusters from the beamlines.
- Beamlines networks will be isolated from each other.
- If there is proprietary or classified work carried out on a beamline, additional data access controls will be required.
- Currently have a single point of failure in the Cisco core switch.
- The network infrastructure allows for the beamline networks to be extended logically into offices and labs as required.

## 5.5 Integration of detectors into EPICS

- EPICS application exists to connect to Multi-Channel Analysers. It is designed to be device independent. Device level support needs to be developed for new MCAs.
- Newer generation XIA detectors will provide PXI support.
- Many detectors provide a Windows based API, which EPICS can connect to.

## 5.6 Performing feedback in EPICS

- EPICS provides facility for PID control. This is more flexible and economical that dedicated controllers.
- Feedback can operate at speeds of up to 10kHz with suitable devices and drivers.
- Feedback is much slower (10Hz) if channel access calls are required.
- Example of fast feedback is adjustment of DCM second crystal to maintain downstream beam position.

## Appendix A: List of presentations

| | |
|---|---|
| Mark Rivers | EPICS for beamline controls |
| Nick Hauser | Gumtree: An Integrated Scientific Experimental Platform |
| Julian Adams | Mature Graphical User Interfaces for Protein Crystallography Beamlines |
| Mark Rivers | Python, IDL and EPICS as Experimental GUIs |
| Mark Clift | LabVIEW as an Experimental GUI |
| Steven Banks | Overview of Machine Control System Software Development Environment |
| Andy Starritt | Prototype Delphi Operator Interface |
| Bryce Karnaghan | Beamline Personnel Safety System |
| Matt Tuffin | Network Infrastructure at Australian Synchrotron |
| Peter Turner | MMSN and Marysville Workshop |
| Nick Hauser | Remote Access to OPAL at ANSTO |
| Colin MacRae | Remote Access to CSIRO Microbeam Laboratory |
| Mike Sargent | Grid-Enabling of Australian Synchrotron |
| Mark Rivers | Integrating Detectors and Implementing Feedback with EPICS |
| Julian Adams/ Richard Farnsworth | Data Storage Requirements for Australian Synchrotron |

## Appendix B: Attendees

| **Person** | **Organisation** |
|---|---|
| **Workshop** | |
| Julian Adams | Australian Synchrotron Project |
| Steven Banks | Australian Synchrotron Project |
| Andy Broadbent | Australian Synchrotron Project |
| Alan Buckley | University of New South Wales |
| Mark Clift | Australian Synchrotron Project |
| Richard Farnsworth | Australian Synchrotron Project |
| Richard Garrett | ANSTO |
| Chris Glover | Australian Synchrotron Project |
| Nick Hauser | ANSTO |
| Robert Hobbs | Department of Innovation, Industry and Regional Development |
| Asad Khan | Monash University |
| Wayne Lewis | Australian Synchrotron Project |
| Mark Rivers | University of Chicago/APS |
| Chris Ryan | CSIRO |
| Andy Starritt | Australian Synchrotron Project |
| Matt Tuffin | Australian Synchrotron Project |
| Jose Varghese | CSIRO |
| Kia Wallwork | Australian Synchrotron Project |
| **BAG Meeting (additional attendees)** | |
| John Boldeman | Department of Innovation, Industry and Regional Development |
| Paul Carr | Australian National University |
| David Cohen | ANSTO |
| Dudley Creagh | University of Canberra |
| Paul Davis | GrangeNet |
| Ian Gentle | University of Queensland |
| Rod Hill | CSIRO |
| Catherine Kraina | Department of Innovation, Industry and Regional Development |
| Rob Lewis | Monash University |
| Colin MacRae | CSIRO |

| **Person** | **Organisation** |
|---|---|
| Ian Madsen | CSIRO |
| Mike Sargent | |
| Andrew Skewes | Multimedia Victoria |
| Peter Turner | University of Sydney |

## Appendix C: Glossary

| Acronym | Translation |
| --- | --- |
| API | Application Programming Interface |
| APS | Advanced Photon Source (Chicago) |
| ASP | Australian Synchrotron Project |
| BAG | Beamline Advisory Group |
| DCM | Double Crystal Monochromator |
| EPICS | Experimental Physics and Industrial Control System |
| FTP | File Transfer Protocol |
| GUI | Graphical User Interface |
| IDL | Software package for data analysis and visualisation |
| LDAP | Lightweight Directory Access Protocol |
| MCA | Multi Channel Analyser |
| MEDM | Motif Editor and Display Manager |
| PID | Proportional Integral Derivative (feedback control) |
| PSS | Personnel Safety System |
| RRR | Replacement Research Reactor (ANSTO) |
| SLAC | Stanford Linear Accelerator Centre |
| SSH | Secure SHell |
| SSRL | Stanford Synchrotron Radiation Laboratory |
| VB | Visual Basic |
| VLAN | Virtual Local Area Network |
| VM | Virtual Machine |
| VPN | Virtual Private Network |