Science Studio

A Project Status Update

D. Liu, E. D. Matias, D. Maxwell, D. Medrano - Canadian Light Source, University of Saskatchewan
M. Bauer, M. Fuller, N. S. McIntyre - University of Western Ontario
Y. Yan - Concordia University
C. H. Armstrong, J. Haley - IBM Canada

Web Interface

The web interface aims to provide users of Science Studio and the VESPERS beamline with a rich user interface that provides all the functionality a user would expect if using the beamline locally. The interface is designed to be usable over commodity broadband internet using the Firefox cross-platform web browser with no additional plugins or extensions. It is known to work with other browsers, provided they support the Canvas HTML tag. AJAX is used to get the current device values and to set device values in pseudo real-time. The JavaScript framework, ExtJS, provides advanced GUI elements.

Web Application

The web application uses the J2EE Servlet API to provide a web-based user interface to users of Science Studio. This web application uses the Spring framework to provide inversion of control using its Model-View-Controller (MVC) implementation. Object Relational Mapping (ORM) support is provided by the iBATIS framework which cleanly isolates SQL commands within XML mapping files. The security framework JSecurity (recently renamed to Apache Ki) is used for authentication and authorization functionality. Currently, this web application is deployed on an Apache Tomcat application server.

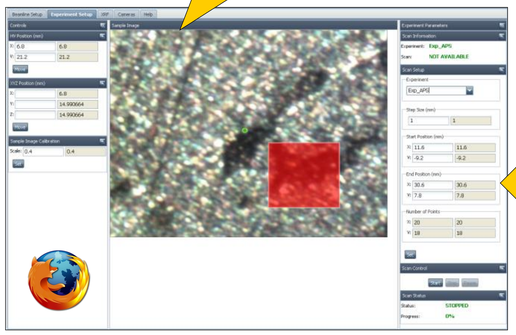
The web application is divided into two parts, the Science Studio Core application and the VESPERS beamline application. The Core application is responsible for providing general access and control of the business objects. The VESPERS application is responsible for remote control of the VESPERS beamline and it maintains the current values of devices by listening to messages from the Beamline Control Module (BCM). When the VESPERS application receives an HTTP request for the value of a device it simply responds without consulting the BCM. When the VESPERS application receives an HTTP request to change the value of a device, it publishes a message to the BCM requesting a value change.

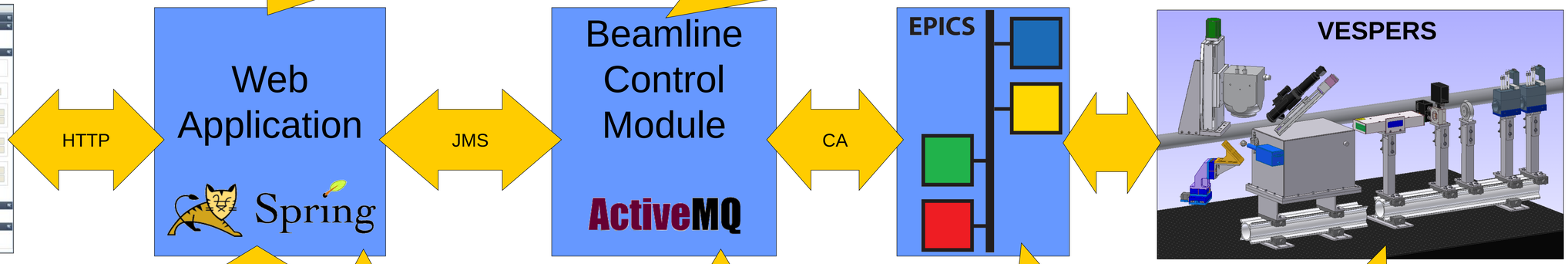
Beamline Control Module (BCM)

The BCM is a Java application which provides a high-level interface to the low-level control system. In this case, EPICS is the low-level control system and the BCM communicates with it using a Java implementation of the Channel Access protocol. The BCM provides a device abstraction so that alternate low-level control systems can be used. This is important for use of the BCM outside of the CLS. BCM abstract devices can be logically organized into a device hierarchy where basic devices are combined to form more functional devices. When an event is generated by EPICS, it is received by the BCM using a basic device which is connected to EPICS via Channel Access. This basic device then asynchronously publishes an event, within the BCM, that can be handled by other devices and in turn may publish more events.

The BCM uses message queues to communicate with external applications. When the BCM wants to publish an internal event to an external application it constructs a message from an event and then adds that message to its outgoing message queue. Likewise, the BCM receives messages from external applications by listening to its incoming message queue. When the BCM receives a message, a handler takes the appropriate action based on the message. Most often an external application is requesting to change the value of a device. The new value propagates down the device hierarchy until a basic device sets the new value in EPICS using Channel Access. Apache ActiveMQ provides the messaging service for the BCM.

The BCM provides an abstraction of the low-level control system into a collection of virtual devices. The BCM receives events from the control system and publishes messages to external applications. In this way the BCM can aggregate low-level control system events into high-level devices messages. The virtual devices may also transform data acquired from the low-level control system so that it can be provided to external applications in a more useful format.

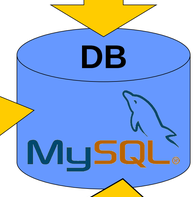




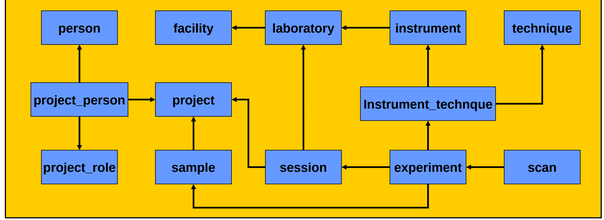
Database

The Science Studio database contains metadata associated with the operation of a remote controlled beamline and the organization of experimental data collected on that beamline. The four main business objects are: *project*, *session*, *experiment* and *scan*.

A *project* is the top level organizational unit, and is associated with a project team. Each team member is assigned a role, Observer or Experimenter, within the project. Experimenters have full access to the project, where as Observers have read-only access. A *session* defines a specific period of time allocated to a project team to conduct experiments using the laboratory. The VESPERS beamline is an example of a laboratory. An *experiment* relates a physical sample to an analysis technique. For example, a piece of meteorite is a sample and X-Ray Fluorescence (XRF) is a technique. The application of a technique to a sample results in a scan. A *scan* records the location of the acquired experimental data, as well as, metadata related to the acquisition and format of the data.



Database Schema



Experimental Data Storage

Experimental data collected on the VESPERS beamline using Science Studio is stored at the CLS with data collected from other beamlines in a common directory structure. A large data storage facility is now operational at the University of Saskatchewan as part of WestGrid. In the future the CLS may have access to this facility to store data collected at CLS with Science Studio.

Experimental Physics and Industrial Control System (EPICS)

EPICS is the standard control system at the CLS and is used for control and data acquisition of nearly every device at the CLS. EPICS consists of a network of Input-Output Controls (IOCs) which are connected directly to devices. Each IOC provides a number of Process Variables (PVs) which relate a value to either an input or output from a device and have a unique name. The Channel Access (CA) protocol is used to read or write to any PV in the network without needing to know which IOC provides the PV.

Very Sensitive Elemental and Structural Probe Employing Radiation from a Synchrotron (VESPERS)

The VESPERS beamline is located on sector 6 at the Canadian Light Source synchrotron in Saskatoon. VESPER is a hard x-ray microprobe capable of providing a high level of complementary structural and analytical information. The techniques of x-ray diffraction and x-ray fluorescence spectroscopy are employed to analyze a microscopic volume in the sample. Multi-bandpass and pink beam capability are built in to meet variable requirements.