REMOTE ACCESS TO A SCANNING ELECTRON MICROSCOPE USING SCIENCE STUDIO*

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Abstract

Science Studio is a web portal, and framework, that provides scientists with a platform to collaborate in distributed teams on research projects, and to remotely access the resources of research facilities located across Canada. The Western Nanofabrication Facility is located at the University of Western Ontario and houses a variety of instruments for lithography, deposition and characterization. One of these instruments is an Oxford Instruments X-ray System fitted to a Scanning Electron Microscope. This x-ray system has been integrated into Science Studio. This allows users to remotely access the system and to upload experimental data into Science Studio. Remote control of the instrument is provided using a remote desktop, so users have access to the full capabilities of the instrument. Through Science Studio, access control and session management are also provided for this instrument.

SCIENCE STUDIO

The Science Studio web portal is an extensible platform that allows scientists to collaborate on research projects, and provides remote access to scientific resources. One resource that is integrated into this system is the VESPERS beamline located at the Canadian Light Source synchrotron [1]. Science Studio provides beamline users with remote access to this powerful scientific tool, and allows experimental data to be easily shared among the project team.

Science Studio is also a framework that can be used to more easily enable remote access to other devices. This framework provides session and experiment management features. Session management allows for remote access to be allocated or scheduled for a specific project team. Experiment management allows the project team to organize and share experimental data. Within the framework is a customizable web portal that provides users a single consistent entry-point for remote access and other services. This web application allows users to manage experiment information and experimental data using in a rich web interface. Security features, such as single sign-on and access control, are also included in the Science Studio framework.

X-RAY MICROANALYSIS SYSTEM

The Western Nanofabrication Facility (WNF) is an open user facility at the University of Western Ontario (UWO) for the fabrication of micro- and nano-structures. This facility has an assortment of equipment and instrumentation that provides its users with a wide range of capabilities; including lithography, deposition, etching and characterization [2]. An instrument of particular interest to users is the LEO (Zeiss) 1540XB Scanning Electron Microscope (SEM) with an integrated Oxford Instruments X-Ray Microanalysis (XRMA) system.

The SEM is a stand-alone instrument with specialized hardware and software for device control and data acquisition. The SEM control software is used for
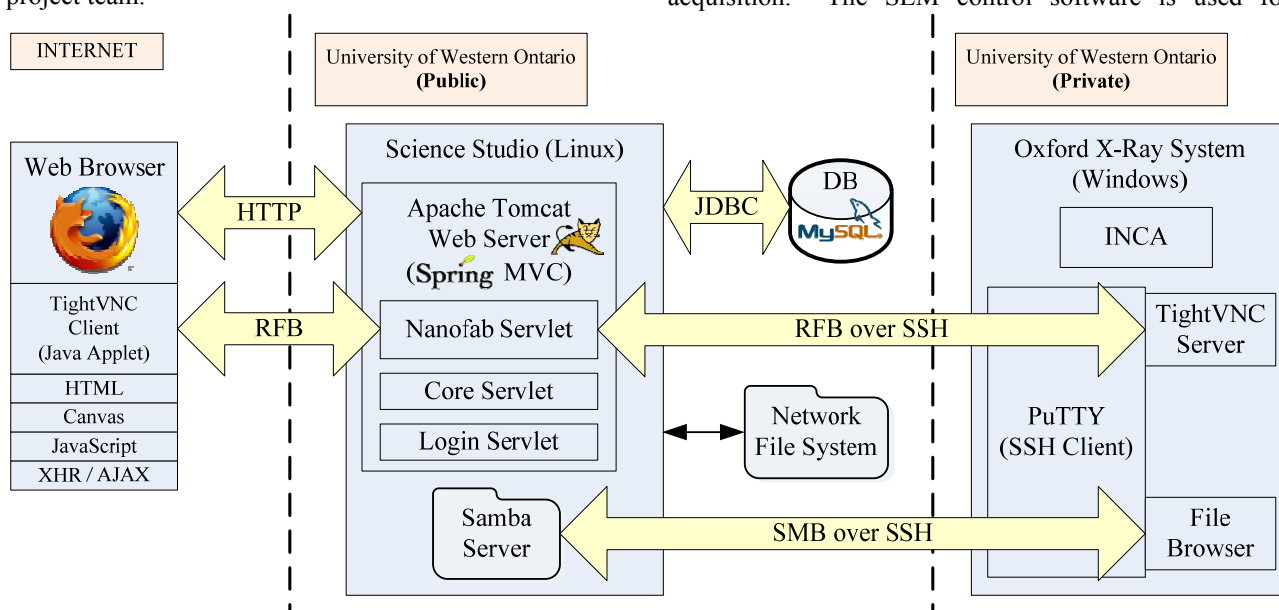

Figure 1: Science Studio architecture for remote access to the x-ray microanalysis system.

Data Networking and Web Technology

Web 2.0 and SOA

positioning the sample at the region of interest, focusing at the desired magnification and acquiring high resolution microscopy images.

The XRMA system includes an x-ray detector, which mounts directly onto the SEM, and the required control hardware and software. This system provides elemental mapping and chemical analysis of the sample *in-situ*. The data acquisition and analysis software for the XRMA system is called INCA. The XRMA system is connected to the SEM to enable data acquisition; however, it has very limited control of the SEM. It is this XRMA system that is available for remote access through Science Studio.

REMOTE ACCESS

Remote access to the SEM control software is not required or perhaps desirable as misuse of this software could result in damage to the instrument. An on-site operator must be present to mount the samples into the vacuum chamber of the SEM. This operator will also be responsible for positioning the sample and focusing the image at the desired magnification. In order to allow the remote user to guide this process, using the telephone or another communication method, they are able to observe the SEM control software. This is done using a VGA2USB [3] frame grabber device that intercepts the VGA output of the SEM control computer and converts that signal to a video stream. This device is connected to the XRMA control computer using USB, and the supplied software is used to view the video stream.

INCA is a powerful application for both acquisition and analysis of experimental data. This software is a highly capable spectral analysis tool, with a well designed, user-friendly, graphical interface. Therefore, it is desirable to provide the user will full access to the INCA software.

To meet this objective a Virtual Network Computing (VNC), or remote desktop, solution is implemented to provide the remote user with direct control of the XRMA control computer, and most importantly, the INCA software. The architecture diagram is Figure 1 outlines the components of the remote access system, and their interaction.

Remote Desktop

The TightVNC [4] remote desktop software is used for this project because of its open-source license, excellent performance and availability of a Java Applet TightVNC client. The TightVNC server supports the use of the Mirage [5] video driver, which provides very efficient screen capturing for the Microsoft Windows operating system.

The XRMA control computer is only connected to the UWO private network. In order to allow remote access over the Internet, an SSH tunnel is established between the XRMA computer and the Science Studio server using the PuTTY [6] SSH client.

Special measures are used to ensure the security of the VNC server without further action required by the user. The VNC server port is protected behind a firewall so it cannot accept connections directly from the Internet. The user initiates a VNC session by sending an HTTP request. When the server receives this request, a tunnel is established to forward network traffic between a random port and the VNC server port. The HTTP response contains the random port number, so the VNC client is able to connect to the correct port. This tunnel will only listen for a short period of time (normally ten seconds) for the VNC client to connect, and it will only accept a single connection.

The screen capture in Figure 2 shows XRMA remote access. In the web browser window, on the right, is the remote desktop session. The INCA software is shown with a region of interest defined by a green rectangle on an image of the sample. The video stream from the SEM control computer is visible in the bottom right corner.
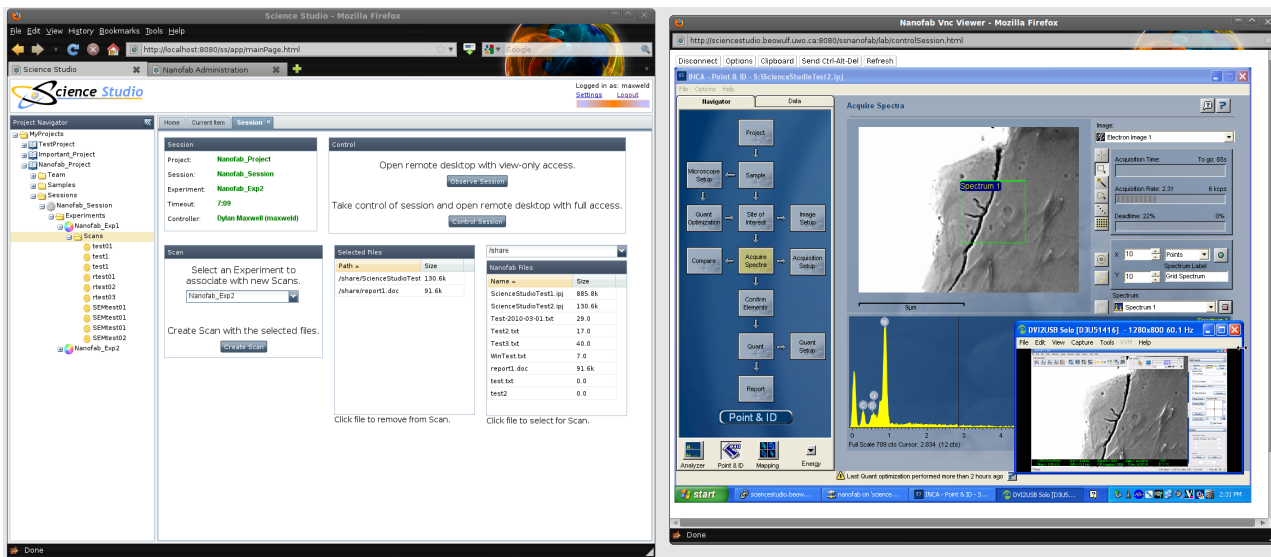

Figure 2: Screen capture of remote access to the x-ray microanalysis system using Science Studio.

Web Application

The XRMA remote interface has two main components. The first component is access to the XRMA computer using remote desktop. The second is a web application that provides the integration with Science Studio. In Figure 1, this is represented by the Nanofab Servlet.

The web application is a rich interface implemented using the Ext [7] JavaScript framework. In Figure 2, the web application is shown on the left. The web application serves two important functions. It allows the user to initiate a remote desktop session with either view-only access or full access to the XRMA computer. And secondly, it allows the user to upload data from the XRMA computer to the Science Studio experiment management system.

When the user acquires data on the XRMA computer using INCA, they save the experimental data files to a network file share that is hosted on the Science Studio server. Then the web application is used to select the files from this share for upload into Science Studio. This will create a scan object within the experiment model.

Members of the project team can then access these files by selecting this scan in the project navigator. The project navigator is shown in Figure 2 on the left side of the web application.

REFERENCES

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[4] TightVNC < http://www.tightvnc.com>

[5] Demoforge Mirage Driver for TightVNC <http://www.demoforge.com/dfmirage.htm>

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