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High Performance Remote Electron Microscopy

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Efforts to explore the feasibility and practicality of operating microscopy instruments from afar have existed for years in various forms [1-4]. The goal of these efforts is to enable the highest possible utilization of a scarce resource—powerful, expensive electron microscopes and related analytical instrumentation. Universities and research organizations require the use of electron microscopes, but may not have the facilities or the capital to acquire and maintain the modern, high-performance, corrected TEM instruments. Past efforts driving remote access sought to utilize users in different time zones to enable a Follow-the-sun work flow [4]. The focus of the current effort is to enable tools to expand local user base and build a critical mass of users by fostering high quality collaborations. Facilitating remote operation to teach and train large groups of students, simultaneously [5-7] helps to build this user base and expand exposure to characterization techniques. Whether an off-campus outreach effort, or a classroom demonstration, these educational efforts seek to build excitement for science, and show the wonderment of "seeing the unseen" to students of all ages. Often an understated benefit of remote operation is assisting staff and researchers in operation and maintenance of the instruments, thus allowing personnel to better utilize facility resources. This last benefit may be a key consideration for a facility deciding to allocate funding to enable such resources.

Frequently, software-based tools such as VNC or Remote Desktop Connection are utilized to achieve remote operation of microscopes, thanks to their ubiquitous nature and low cost [8]. These tools can be invaluable for staff and researchers as they execute long-duration experiments and monitor tedious maintenance operations related to high-vacuum systems, etc. However, this approach has limitations; the high bandwidth and low latency video necessary for delicate operations, such as alignments, require real-time interaction and cannot be properly facilitated by current software solutions. Complicating matters even further, is the continuously changing nature of the software industry, with the eventual retirement of platforms, such as Microsoft Windows XP™, and inevitable obsolescence of future platforms. Also, security issues not only present a prominent obstacle for current procedures related to remote operation of instruments, but also threaten future remote microscopy efforts.

The Center for Electron Microscopy and Analysis (CEMAS), at The Ohio State University, is currently using several technologies for operation of TEM, SEM, and Dual-Beam FIB™ instruments. The facility is also evaluating new and different methods, while exploring multiple remote-operation scenarios. Accessing the facility across both private networks and the public Internet. These techniques have been constantly evolving, since first being implemented in 2007. Ever increasing network performance further enables these remote microscopy efforts and expands the viable range of practical application. A discussion of past lessons-learned and the current state-of-the-art will follow as we describe the implementation of high-performance remote TEM consoles across the state of Ohio using OARnet—the Ohio Academic Resource network. With the implementation of several remote consoles, CEMAS seeks to demonstrate production quality remote operation, act as a hub for research and a regional microscopy resource.

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