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Archive - Potential NGI Applications

Telerobotic Operation of Scanned Probe Microscopes (SPM)
Sponsored by National Institute of Standards and Technology (NIST)

Categories

Manufacturing, Remote Operations, Collaboration

Vision

This project, among its technical goals, aims to demonstrate and implement capabilities for the remote operation of scanned probe microscopy (SPM) systems at various levels of control using standard data representations and controller interfaces for collaborative measurement, research, and diagnostics purposes associated with nanometer-scale dimensional artifacts.

Why NGI?

The collaboratory will require the bi-directional exchange of full motion video, audio, and remote use and diagnostics of scanning probe microscopes (SPMs) that have a high control bandwidth. The lower levels of motion control require minimum latency and a deterministic timing response while the video and data streams will require at least 80 megabits/sec. Current Internet technology can not provide either over a wide area network in a cost-effective manner.

Description

This project is supporting the development and deployment of technology for the distributed fabrication and measurement of nanometer-scale dimensional reference artifacts that are critical to the quality assurance systems within semiconductor and data-storage industries; computer modeling and simulation of associated mechanical systems and components, including artifact transport and storage systems; and real-time network links among collaborating institutions in industry, government, and academia for high-speed video, voice, and data transmission to enable activities that include the remote teleoperation of scanned probe microscopy systems. This project

will: (1) demonstrate the fabrication of physical calibration standards with nanometer-scale geometric dimensions, whose feature sizes and shapes are produced by controlled natural processes such as lattice dislocations, and are in turn determined by crystal lattice spacing and geometries; (2) develop standardized interfaces for artifact transport and storage systems to allow the physical transport and maintenance in vacuum of wafers and other substrates while they undergo processing (and use) in high-vacuum systems in clean-room facilities at geographically distributed locations; and (3) demonstrate the remote operation of scanned probe microscopy systems for collaborative measurement and diagnostic purposes using standardized data representations and controller interfaces.

Rationale

The use of this type of instrumentation is integral to the fabrication and measurement systems associated with nano-scale manufacturing processes. These manufacturing processes, which are typical of the semiconductor and data-storage industries, are increasingly becoming characterized by the conduct of operations at geographically dispersed manufacturing sites with expensive, specialized equipment carrying out different steps of the overall manufacturing process, including R&D, design, fabrication, inspection, processing, or repair, with many of these activities being dependent upon sophisticated computer modeling, communications, and control. High-speed, secure, reliable, and affordable network connectivity for the real-time transfer of voice, video, and data information among the various sites that comprise the geographically distributed manufacturing systems for nano-scale manufacturing is critical to the semiconductor and data storage industries' evolution toward economically efficient manufacturing systems that effectively leverage pooled resources. The development of the technologies that will realize distributed manufacturing hinge upon the ability of scientists and engineers to be able to operate the same pieces of equipment using interoperable software and standard artifacts in order to achieve consistent results. From the federal perspective, these artifacts must be disseminated throughout industry with clear traceability to the international standard of length, which is a unique mission of NIST.

Requirements

The SPM will require the challenging mix of bi-directional full-motion video and audio of the machine (50 Mbps), coupled with uni-directional data collection and microscope control information. The remote operation of the microscope is required to be low latency and deterministic in nature, but is otherwise low bandwidth (4 Mbps, 50 msec latency). The data collection shares the requirements of low latency and deterministic operation, but at higher bandwidth (5 Mbps). The collaboration portions can have greater latency, but requires the same high bandwidth (20 Mbps) as other collaboratories being proposed.

Partners and Potential Partners

National Institute of Standards and Technology, Gaithersburg, MD
Argonne National Laboratories, Chicago, IL
Sandia National Laboratories, Albuquerque, NM
Oak Ridge National Laboratories, Oak Ridge, TN
University of Maryland, College Park, MD
University of Arizona (Tempe, AZ)
Topometrix Inc., Santa Clara, CA.

URLs

http://www.nist.gov/mel/namt