Instrument Development Laboratory

The Instrument Development Laboratory (IDL) designs, builds, and deploys advanced state-of-the-art instrument systems and custom application software in support of the ongoing experimental research efforts in the W.R. Wiley Environmental Molecular Sciences Laboratory (EMSL). As depicted in Figure 1, IDL staff members support EMSL researchers and users by providing a wide variety of design and fabrication services for hardware and software, custom engineered solutions to research problems, and experience in the interface and control of commercial instrumentation. Most EMSL user projects have unique needs; IDL staff members are especially skilled in the integration of commercial and custom hardware/software packages to suit the exact specifications of specific research projects.

Capabilities

Some of the IDL's most recognizable expertise and capabilities fall into the following areas:

- high-voltage expertise
- radio frequency expertise
- high-speed analog and digital systems
- digital signal-processing and field-programmable gate array technologies
- databases
- laboratory automation
- data acquisition
- instrument control
- common communications methodologies
- software design and implementation (C, C++, Visual Basic, .NET, JAVA)
- embedded systems

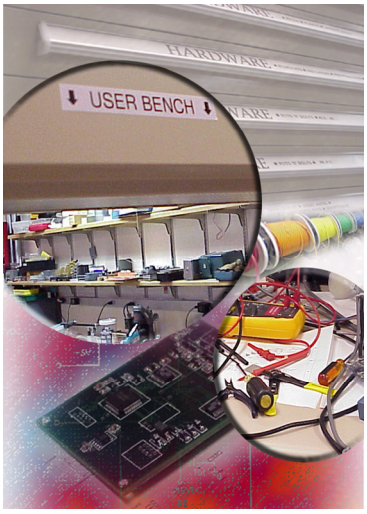

Figure 1. IDL and its staff members provide a wide variety of technical support to EMSL staff and users.

The IDL Design Laboratory offers a staffed electronics and fabrication shop for EMSL research staff and facility users. IDL customers will find a fully stocked parts supply, electronic components and small hardware, test, and measurement equipment available for checkout, and ready assistance during business hours. For immediate hardware assistance, customers may access the IDL electronics laboratory and receive assistance from any IDL staff member. For work that is limited in scope and not time-consuming, there usually is no charge to EMSL staff for services. For larger projects, staff may also access the IDL electronics laboratory and speak with an IDL staff member, who will happily assist the customer in defining the work to be done and begin the process of designing solutions.

Custom Software Design, Development, and Support are critical services offered to IDL customers. IDL staff members specialize in several key services related to research: data acquisition, instrument control, laboratory automation, systems integration, data analysis and visualization, data management and archiving, and handheld and embedded systems. Using a modular code design model as their basis, IDL software developers can efficiently develop software in a number of languages, tools, and scripts (e.g., Visual Basic, Java, C, C++, .NET, Labview, Assembly, Access, and SQL Server). In addition, software developers are skilled in a number of instrument control strategies, including General Purpose Interface Bus, Serial (RS-232), infrared, Transmission Control Protocol/Internet Protocol, Analog and Digital I/O, and high-speed event counting and timing.

The IDL Support Queue is accessible by customers via e-mail (idl-support@emsl.pnl.gov). The queue is monitored daily, and customers are encouraged to submit their requests for any type of service offered by IDL.

The IDL Website at http://idl.emsl.pnl.gov provides a full description of IDL capabilities, access to the support queue, team highlights, recent projects, statement-of-work access, and a downloadable business plan.

IDL Technical Support is readily available to assist research by providing software modifications, troubleshooting, equipment fabrication, and research instrumentation support.

Future Directions

Field programmable gate array (FPGA) technology is being exploited in a new field known as reconfigurable computing. In this approach, programmable logic implements algorithms instead of sequential stored instructions. Performance gains of several orders of magnitude are possible with selected algorithms. This dramatic improvement is clearly applicable to supercomputers and needs to be fully exploited if EMSL is to remain on the leading edge of the computational sciences. This effort may include FPGA architecture investigation, inter-FPGA communication, algorithm design and implementation, and testing and validation.

Digital signal processing needs to be more extensively exploited to improve the performance of existing instruments. Doubling the signal-to-noise ratio of a given instrument is equivalent to acquiring a second instrument without the cost, support, and floor space.

In the coming year, IDL software developers will be porting a number of programs from Visual Basic 6 to the newer .NET platform. This change will enhance the functionality of existing software, while maintaining IDL instrument control capabilities at the software forefront.

Proteomics research results in large datasets requiring information management systems that enable high throughput. The data production from imaging research can easily exceed the data volume produced by proteomics. These two emerging areas have highlighted the importance of information management. Facility staff members have person-years of experience with the Proteomics Research Storage and Management System system, and this

technology is readily transferred to the imaging domain. As more projects and users rely on data management, an obvious need for a common platform emerges. It is essential to build this capability in EMSL. Development to date has been completed on projects specific to proteomics and imaging. We will continue to develop this capability to allow EMSL to support more users and increase the amount of research that can be accomplished with limited resources.

In the next year, ion mobility mass spectrometry has the potential to reshape the proteomics landscape by increasing the depth of proteome coverage while speeding up liquid chromatography separations from a few hours to a matter of seconds. Hadamard transform ion mobility mass spectrometry has the potential to further increase sensitivity by up to 10 to 50 times. IDL staff will play a key role in developing the hardware and software necessary to develop this challenging and valuable capability.

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