University of Rochester's Laboratory for Laser Energetics Turns to LonWorks®

An example of how LonWorks is used within a very complex control application.

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As part of the national fusion research program, the University of Rochester s Laboratory for Laser Energetics fouces on inertial confinement, solid-state laser fusion power as a clean, renewable energy source. Among nuclear fusion s benefits are an inexhaustible source of energy (extracted from sea water), no long-half-life radioactive byproducts, and energy independence. The laser system has an implosion velocity of 225,000 mph; laser power of $5x10^{13}$ W; and fuel temperatures of $5x10^{7}$ °C.

The Problem

When the Laboratory for Laser Energetics (UR/LLE) needed to upgrade its 12 year old Omega laser system, they realized their existing control system would not be able to handle the increased control requirements. Central intelligence for the existing control system was provided by PDP 11's which controlled A/D's, stepper motors (~350), and digital I/O.

The old Omega laser, a 24-beam, frequency-tripled glass laser system, was used for over 10,000 target shots over its life. Stepper motors provided motion and were controlled by multiplexing several CAMAC stepper controllers. All cabling in the laser bay returned to a central location making the system extremely difficult to maintain and expand.

The system needed to grow to more than five times its current 2,000 control points. More importantly, a control system was needed that would have the ability to continue to grow.

The Solution

The engineers at UR/LLE turned to a distributed control solution based on Echelon®'s LonWorks technology to solve their control needs.

The new control system would have over 10,000 control and acquisition points including over 3,000 A/D channels, 2,000 DC servo motors, and approximately 4,000 digital I/O channels. The Omega Upgrade laser is a 60 beam, frequency-tripled glass system with a 60 minute, shot cycle time and an expected life at least 10,000 target shots.

LonWorks technology was chosen as the backbone for this distributed control system due to its ability to support the requirements of the project at many different levels. Important to the project's success was also the availability of key off-the-shelf components needed to support the control system. A Neuron In-Circuit Emulator available from Distributed Controls, Engenuity Systems VME-LTNI LonTalk® Network Interface, and various component-level products available from Echelon and Motorola have allowed engineers at UR/LLE to concentrate more on developing the overall control application and less on developing individual pieces.

At the lowest level of control, nodes with Neuron 3150 chips running at 5 MHz. provide the intelligence

for the individual devices. Each Neuron controls multiple points with more than 1,600 Neurons on 20 twisted pair channels in the overall system. Some of the key features the UR/LLE engineers found in LonWorks were self identifying nodes, support for automatic download of application programs, communications via network variables, networked addresses based on crate and slot numbers, ability to notify the host of asynchronous events, periodic health check of each Neuron, and easy replacement of components.

A cardcage packaging scheme has been adopted to ensure modularity and expandability of the system that allow nodes to be quickly deployed. These Neuron-based nodes communicate across both passive backplanes within the UR/LLE cardcage as well as across standard 1.25 Mbps or 78 Kbps twisted pair networks with up to 50 card cages.

Each individual network, in turn, is connected to a SPARC workstation. These VMEbus-based workstations run host applications using a Solaris operating system. Engenuity System's VME-LTNI LonTalk Network Interface provides the interface into the VME chassis, allowing data from each of the LON channels to be passed back to the host system for display and data processing.

Software also plays a pivotal role in the Omega Upgrade control system. Network variables supported by LonWorks technology align well with the object oriented design of the executive processes. Module Objects allow communication with the individual Module Firmware for each intelligent node via a request/response protocol using network variables. Dataless commands are used to pass control and status information while commands with data have their own network variables allowing data to be acquired by polling the appropriate individual module.

All together, firmware for nine different types of applications, more than two dozen hardware designs, and products from dozens of companies have been brought together into the Omega Upgrade distributed control system. For more information about this project or the products and technology used to implement its distributed control system, contact Tracy Markie of Engenuity Systems at (480) 782-5600.

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