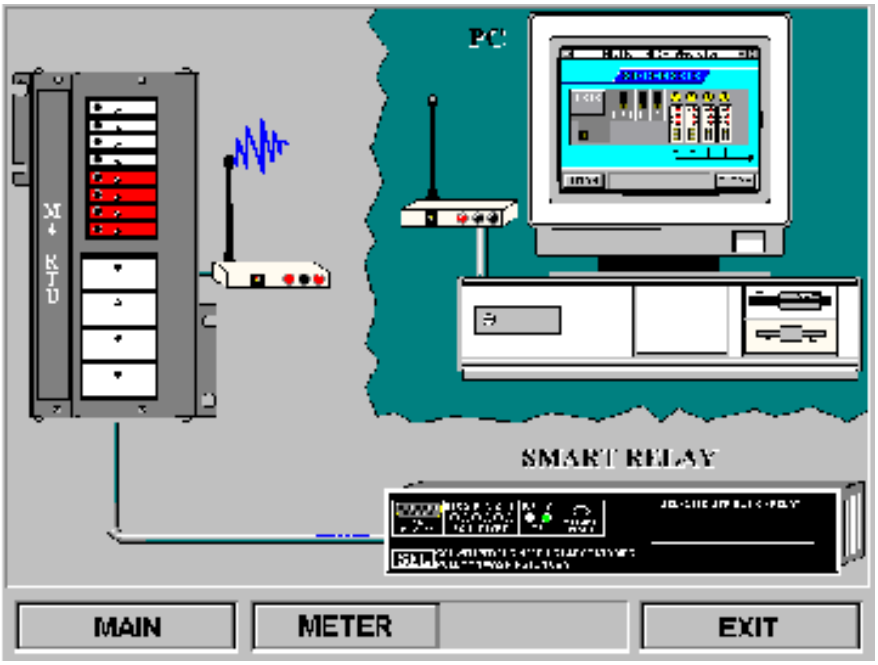
PC-Based Remote Automation System Sheds New Light on Utility's SCADA Operation



Electrical Substation Automation

The process of upgrading or replacing obsolete Supervisory Control and Data Acquisition (SCADA) equipment can be challenging. When Wisconsin Public Service Corporation (WPS) decided to replace a number of Remote Telemetry Units (RTUs) at a station near Green Bay, both traditional and nontraditional RTU manufacturers were approached. Many offered solutions that were cost-prohibitive, while others offered products with limited functionality. After all alternatives were considered, WPS selected a PC-based remote automation system that met all requirements and offered the opportunity for further expansion — yet cost one-third of a traditional RTU system. Opto 22 provided that system.

The replacements were scheduled for the SCADA portion of the Energy Management System (EMS) at some of the firm's substations and power plants — 12 locations in all. The locations are key elements in a system that has a generating capacity of 1,800 Mwatts, and serves 537,000 customers in Northeastern Wisconsin and the upper peninsula of Michigan. The WPS EMS is a network of PCs and field devices that monitor and control the generation, transmission, and distribution of power throughout the WPS system. The SCADA software for the overall EMS resides on the network. The PC network also operates as a front-end server and is linked to devices in the field. WPS originally installed conventional RTUs to link the substations and power plants to the EMS. These RTUs had a very limited functionality and could only perform a single preprogrammed task — data acquisition and control. WPS has used PLCs as RTUs with mixed results. The 15 PLCs used provided local control, but could not be programmed to communicate with the Westinghouse Redac 70H protocol employed by WPS's EMS. The cost of the PLCs and their user interface also prohibited PLC use at small sites. WPS began investigating new methods in order to develop substation and plant-level SCADA.

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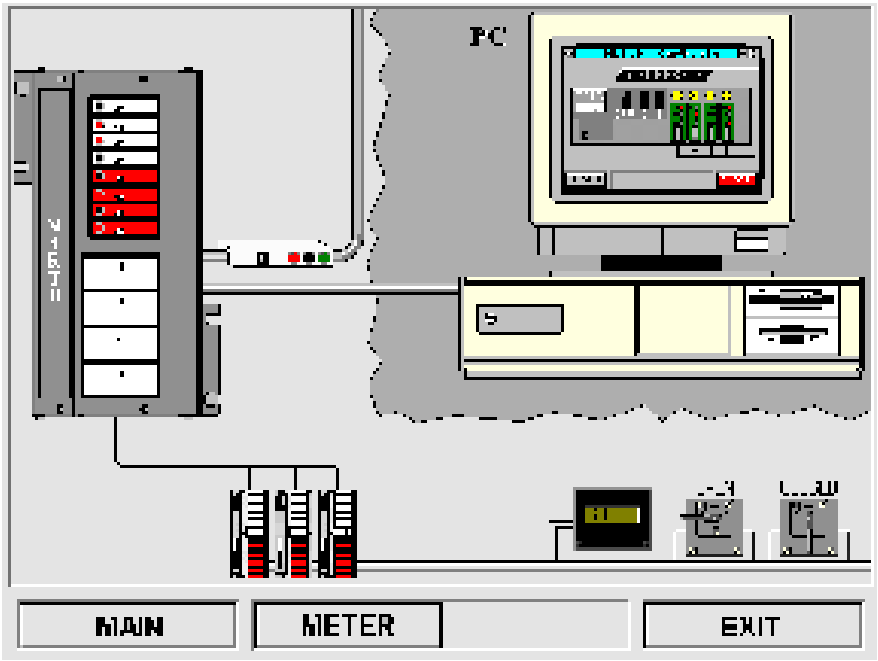


The proposal from Opto 22 utilized the company's Mistic Industrial Automation System, a completely integrated hardware and software solution for industrial control applications. Opto also suggested using the Mistic M4RTU, an open, expandable control processor with on-board intelligent single-point I/O and communication capabilities, designed specifically for remote applications.

WPS evaluated each alternative for user-programmability; a cost effective, easy-to-use operator interface; and the ability to communicate utilizing several protocols. When the evaluation was complete, WPS decided that the Opto 22 solution was superior to any other supplier's proposal.

The first requirement — user programmability — is satisfied by Mistic's Cyrano Control software and the Mistic MMI operator interface software. Both are packages that utilize object-oriented programming techniques and a shared database. Also, the Mistic MMI fulfills the requirement for a cost-effective, easy-to-use operator interface. The sophisticated communication capabilities of the Mistic system support all of the protocols employed by WPS, including Redac.

The base configuration of the M4RTU features two built-in serial ports. However, the port configuration is expandable and WPS added an additional dual serial port card to communicate with other devices. In this application, the first port is RS-232, used for host communications with PCs or other processing units that are interfaced to standard telephone lines, leased lines, and radio transceivers. This port allows WPS engineers to link the M4RTU to the plant's Distributed Control System (DCS). As a result, it can be utilized to control generators, link the host EMS and the DCS, and reduce wiring through distributed I/O ports using shielded twisted wire in each panel.

The second port, an RS-485, facilitates communication with additional I/O or third-party devices such as intelligent field bus devices and analyzers. At WPS, this capability is used to connect the substation SCADA to Intelligent Electronic Devices (IEDs) such as protective relays and kilowatt hour meters. A third port is dedicated

to communications with the PC running the Mistic MMI, and the fourth port supports communications with the EMS via a WPS radio system.

Automatic Control Functions

WPS installs one Mistic system per substation. It is connected to remote I/O, which resides in various equipment panels inside the substation control house. The substations vary in size and the I/O count at each reflect these differences. One very small substation has only one digital and one analog point. For larger substations, such as the WPS facility with 48 analog (high-density) and 150 digital points, the Mistic system's RS-485 port is used to access I/O points via intelligent Mistic I/O bricks.

One major advantage of the Mistic system over conventional RTUs is the ability to provide automatic control functions — the result of programming with the Cyrano Control Software and its intelligent I/O capability. It has been programmed to provide automatic circuit breaker reclosing and automatic bus sectionalizing control, among other operations. Mistic's intelligent I/O is capable of many independent functions, including PID control loops, pulse train measurements, high-speed latching, and peak-and-valley measurements. Complete optical and electrical isolation protects the system from severe electrical transients.

Mistic I/O bricks provide remote trip and close of electrical circuit breakers as requested from the system operating department office. The fact that the Mistic system can be easily programmed to emulate WPS's current protocol provides an enhanced substation control system without requiring the replacement of the EMS host computer. The protocol is emulated by a number of charts in Cyrano. Communication to the host is accomplished via an RS-232 port and external modem. The modems are connected to dedicated leased telephone circuits to the system operating office. The system is also interfaced to a 928/952 MHz multiple address radio system.

WPS has developed another advanced communication application that takes advantage of the unique dual-processing architecture inherent in the M4RTU. While a second processor performs I/O interfacing and control of signals from the substation, the M4RTU's high-speed 32-bit processor manages communications between the EMS and a plant DCS, providing the bridge between the EMS and DCS to control power generators. The Mistic system is delivered to customers with the hardware communication drivers for Allen Bradley's Data Highway, Modbus, and more. In this case, the DCS communication is Modbus and the EMS communication is Westinghouse Redac 70H.

The flexibility of the Opto 22 system also frees WPS to change EMS communications protocols in the future.

Man-Machine Interface

WPS developed the operator interface for its Pulliam Power Plant Station with the Mistic MMI software. The site, one of the most important substations in the Green Bay area, includes two 115 KV lines, two 138 KV capacitor banks, six 138 KV lines, and two bus tie breakers.

Operators now access several screens to control and monitor all of the important activities at the substation. The screens include a one-line diagram of the substation showing breaker status and line flows, a detailed metering display, a bus voltage trend chart, alarm annunciator, a software control switch status screen, and breaker control switch screens.

The Mistic MMI provides WPS with a sophisticated object-oriented drawing environment and includes a symbol library with 3-D graphics and the standard ISA symbol library. With the MMI software, graphical objects are linked to I/O points, control variables, monitor alarm status, log data to disk, and trend real-time information. Also, the Cyrano Control Software and the MMI utilize a shared database. This eliminates cumbersome cross-referencing, and improves accuracy.

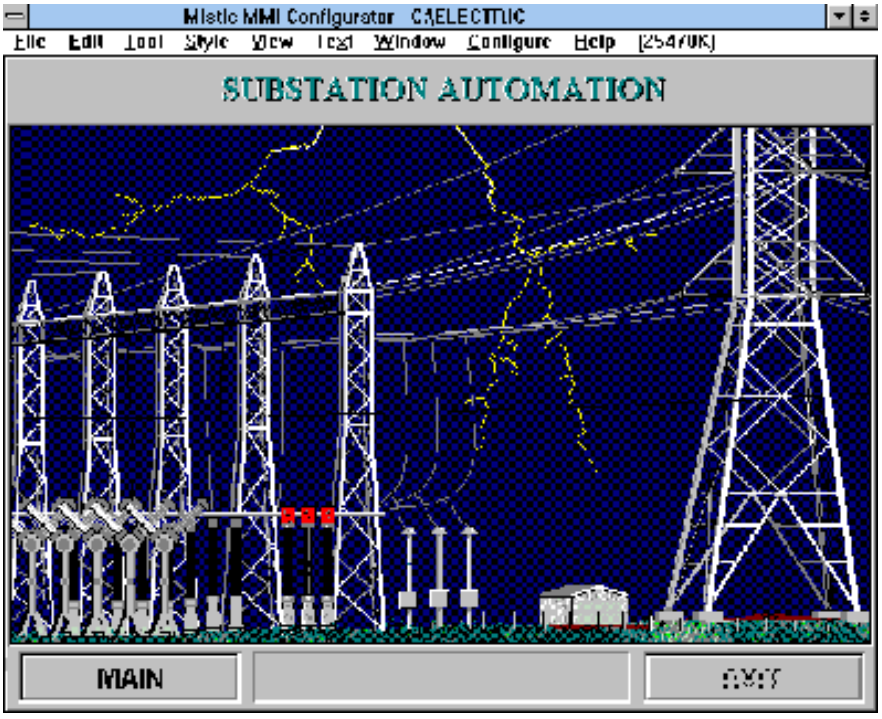
Reliability of the MMI is an absolute requirement. The PC running the MMI operates 24 hours a day, seven days a week. The substation is normally unstaffed, and only opened to operators for maintenance or inspection of equipment. Utilizing a touch screen on the PC, the operator uses the MMI to view the desired data. From the main menu, the operator typically navigates to the one-line diagram of the substation. This is a graphical display of the line flows, bus voltage, and breaker starts at the substation.

The graphical objects of the equipment resemble the devices they monitor, changing color and blinking as the status changes. Animated digital displays near each graphical object supply data to the operator in an easy-to-understand summary. The operator may access a variety of screens to monitor and control the substation's functions. The metering screen provides detailed line flows with Mwatt, MVARs, Mva bus voltage, and frequency information in a digital display. Again, the graphical images resemble the items they monitor. This eases interaction, and virtually eliminates error. For example, when the operator is required to close a circuit breaker, the person searches for a screen object that looks like an open circuit breaker. Once the object is located, the operator simply touches the screen object and it changes to an image of a closed breaker. At the same time, the MMI communicates this request to the M4RTU and it closes the actual circuit breaker. The operator also has an alarm annunciator window open at all times. Normally, it is a box at the bottom of the screen with scrolling text. If a serious alarm is announced, the box fills with a red background and it begins to flash. This warns the operator to investigate the alarm further.

The MMI is constantly historically logging information. As a result, this information is available to the EMS. Operators can then access a trending application on the EMS to view information presented graphically as line charts and bar graphs of historical data, including minimum and maximum values.

Additional Applications

The M4RTU and MMI were brought in as part of a major change in the WPS control philosophy. Successful implementation of the system in the early stages of deployment has allowed WPS to quickly incorporate the



new technology in other areas. The transportability of the Mistic software has been a key factor in this effort. After building up blocks of logic from the initial Mistic installation, WPS has been able to easily transport the software to other substations, resulting in a valuable savings in engineering time. In some cases, this leaves the engineers with little else to do at the new site but to change tag names and a few I/O points.

Mistic's role at WPS has increased both within the individual substations and in the total number of substations it now serves. Inside the substations, for example, Mistic is being employed for controlling parallel load tap changing transformers. This involves monitoring changes in voltages and tap position for each transformer in order to maintain proper voltages and at the same minimize LTC operations. In addition, the Mistic systems have been installed for use in measuring tension on power lines.

Another interesting use is at the Potato Rapids Dam, a hydroelectric dam located near Marinette, WI. Here, Mistic is monitoring the headwater elevation in order to ensure that WPS is meeting government-mandated water level requirements. The headwater level is adjusted by controlling the generator operation. WPS has been able to integrate the Mistic product with some very old (circa 1920) equipment at the dam for use in creating an historical log that facilitates the process of calculating and recording discharge rates at the dam.

Mistic's capability to communicate with IEDs is also being exploited by WPS to develop a new application that could result in a major cost savings for WPS. The Mistic system will be used to read and write data to substation protective relays and electronic meters. (The protective relays contain fault data that is useful to the EMS.) It will be programmed to automatically read and send the fault data to the system operating office. This will provide WPS with fault type and location data at the system operation office, allowing the utility to dispatch line repair personnel to the exact location of the fault.

Presently, the repair personnel patrol the faulted line to detect problems. The new application will reduce the need for time-consuming on-site patrolling, and through quick detection of trouble spots, will allow WPS to more quickly restore service to customers.

Return on Investment

The implementation of Mistic versus a traditional substation control design saved WPS money in overall equipment costs. Return on investment can be illustrated by examining the Mistic system installation at the Pulliam substation in Green Bay. WPS conducted extensive research into the cost of installing a new traditional control system, which consists of numerous control panels, control switches, panel lights, annunciators, panel meters, strip chart recorders and reclosing relays. After comparing the costs to the PC-based system from Opto 22, WPS found the savings with Mistic to be considerable. The equipment costs for the traditional design were approximately three times the cost of Mistic (128 digital inputs, 32 digital outputs, and 48 analog inputs) at the Pulliam substation. As an added benefit, WPS also found that the Mistic system design greatly reduces construction labor costs as compared to the traditional approach.

Another important cost-aspect is the one-time license fee offered with the Mistic MMI. Traditional license arrangements would require fees for each substation and facility at WPS, plus fees for individual nodes at headquarters. However, with the Mistic MMI, only one fee is paid and WPS can add as many sites as required without incurring additional costs. This translated to a substantial savings for WPS.

As more and more uses of the Mistic system are explored by WPS, the company is certain to benefit from additional cost and time savings. This, after all, is why new technology is purchased to begin with. More importantly, the savings are passed along to the consumer.

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