Low Cost Scada Systems

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Abstract

Data gathering and alarm systems have historically been priced out of reach of the small oil producer. This paper deals with systems affordable to the independent operator. It explains specifications offered by suppliers and requirements needed to operate different applications. It also touches on different types of software and when it should be incorporated into the system.

Introduction

Scada systems have long been a mystical process, affordable only to the major oil companies with large operating budgets. This is because the systems have been complex and user friendly only to a handful of experts. The smaller operator can not afford a team of technicians and computer programmers to install and maintain these systems. The benefits and cost savings of these systems cannot support the cost of operating such a system on a smaller scale. This paper will deal with systems affordable to the low end user.

SCADA

Scada is an acronym for supervisory control and data acquisition. Breaking this down to it's base elements, supervisory control can be anything from complete automation systems that open and close valves, turn pumps on and off, and other operations, based on incoming data to a simple remote contact closure to turn off a pump.

Data acquisition can be as simple as one alarm point alerting the operator of a malfunction. It can also be as complex as required. Acquiring the status of all equipment, all pressures, all tank levels, and any other point imaginable on a location.

Scada systems can be designed to only give the minimum information required, thus saving thousands of dollars in unused equipment. Expensive and high maintenance computerized systems can be avoided, thus reducing initial costs and ongoing maintenance expense.

The independent operator may not care what the fluid level is in a stock tank, only that it is not at a level dangerously close to running over. He may not care why a pump is not running, i..e. high pressure, etc., only that it needs attention. If this is the case, expensive analog transducers need not be used. A simple float switch or pressure switch can be utilized at a fraction of the cost.

The first step in designing a functional system is understanding what the vendor is selling. To do this, a basic vocabulary is required. A list of common terms used in product specifications is provided at the conclusion.

Design

The next step is to evaluate what will be required. The operator has to first decide what data he wants to receive. He then needs to determine if it is critical to have the information as an alarm point, or as a numerical value, such as a stock tank level in feet.

The environmental aspect of the location must be reviewed. Is their power available, or will a system be required to furnish power to the unit. Is a local telephone line available, or will radio or cellular equipment have to be purchased.

How critical is the reliability of the alarm system. Will failure to receive an alarm lead to an expensive equipment repair or costly spill, or will it merely be a nuisance resulting in a little lost production.

The location of the RTU equipment on site should be determined. If the equipment can be housed in an existing control room or office, more costly weatherproof enclosures are not required.

Ease of installation, maintenance, and programming must also be considered. Saving a little money initially could lead to high installation and maintenance costs later.

A simple alarm system can be built for less than two hundred dollars. This system is not adequate for most applications, but it does give a cost basis on which to build. This system utilizes a low cost phone dialer. A system of this type gives only one alarm, needs local power available, requires a phone line, must be housed out of the weather, and only calls out one time when an alarm is active. This system can not be remotely polled to confirm status of alarms.

Using this as a starting point, a system can be designed to fit the needs of any operator and still maintain a low cost profile.

The method of data transmission must be addressed. Local telephone lines can be utilized very economically. However, this is usually not available at the remote sites. Radio systems can be used. This method works well and is cost effective, providing the operator has a fleet radio system in place. This is normally not the case for the small independent user. Also, most radio systems need a computer interface to display the alarms. This increases the cost of the installation.

Cellular phone systems have proven to be the best alternative for most applications. Cellular coverage is adequate in most areas and provides reliable service. Satellite phone service is also available if other types of communication are not feasible. This service has a high initial cost, and usage charges are high compared to cellular.

The reliability of the unit has to be evaluated. If reliability is critical, safe guards should be built into the system to insure alarms are received. The unit needs to verify a call has been received, or continue to alarm periodically until the system has returned to normal operating conditions. This can be achieved with a simple reset timer, at a cost of approximately one hundred dollars, or with more complex phone dialers costing hundreds of dollars. The more complex and costly the system, does not necessarily increase it's reliability.

The specifications should include an acknowledge option. This requires a human interface at the other end of the line to enter a code verifying the alarm has been received by a "qualified" party. A multi-call or phone list option gives the user the flexibility of having more than one telephone number programmed into the memory. A multi number system will go down a preprogrammed caller list until someone answers and enters an acknowledge code. On some units, different phone lists can be used for different alarms, thus notifying the proper personnel for each situation. Other systems can include calling to a personnel pager. These options do not come without extra cost, however, prudent shopping can obtain them economically.

The next aspect to consider is power requirements. The system should have battery back up capabilities to increase reliability during power outage. The system should have a built in low power alarm to notify personnel of problems. This eliminates the need for large battery backup systems. However, if response time is slow, critical alarms could be missed during the power failure. Backup power requirements should be based on the needs of each installation.

If local power is not available, charging systems such as solar panels will be required. Solar systems can cost from two hundred dollars up, depending on system power requirements. Other options are wind generators, hydro-electric power, and power generated by equipment on location. One economical charging system consists of an alternator, similar to that found in a car, driven by a gas engine powering the pumping unit or gas compressor.

Data Acquisition

The data required from each location should be evaluated. The type of information required will determine the requirements of the alarm equipment. It will also determine the associated cost of the sensors used, cost of installation, and ongoing maintenance costs. A digital input alarm only requires a contact closure to trigger a call. To send analog alarms or specific data, transducers must be installed to provide the voltage signal required to operate these inputs. This equipment is more costly to install, and maintenance costs are higher. Technicians with the proper training and metering equipment must be used to calibrate and repair the end devices.

After the basic system has been designed, the number and type of alarms required should be considered. The user needs to determine how specific the information brought in from the site needs to be. Is the extra cost incurred by the use of a system with multiple alarms justified by the extra information obtained? If all of the points monitored require the same urgent response to the location, is the knowledge of which alarm is active necessary?

The use of multiple points will probably pay for the extra cost. The operator can better organize his time if he knows the status of his remote site. He may get an alarm indicating he has a water transfer pump down. Knowing the pump is down, but the water tank does not have a high level may give him time to complete other duties before responding. With the knowledge that the pump is down and there is also a power failure, he may be able to call necessary personnel to make electrical repairs before incurring a high tank level.

It is also advantageous to have a system that can be remotely polled. After an alarm is received, it can be beneficial to be able to call and verify the alarm is still active before responding. A power fail is a good example of this type of situation. Power can be restored to the location immediately after the alarm has been generated. Without the option to verify alarms, the operator would have to drive to the location to verify the power was back and equipment was functioning normally.

Future expansion should be strongly considered when purchasing equipment. What appears adequate today may not serve the needs later. Any number of possibilities could effect the requirements of the existing system. Equipment may be changed or tanks added. The system may be moved to a different lease with different requirements. To prevent completely scrapping a system and starting over, it may be cost effective to build in a few options for future expansion.

It is not necessary to buy equipment that has all the requirements for future needs. Expansion units are available for most systems. Computer interfaces for data processing and report generation can be added later if desired.

Supervisory Control

The supervisory control element of the SCADA system can also be implemented in the lower cost equipment . The more complex multi - point systems have options to remotely input codes that can open or close contact points in the unit. With these points equipment can be turned off or on. If a high tank level alarm is received, the operator can turn on a transfer pump, or turn off a producing well, eliminating a possible spill. He can then poll the unit to check on the status of the high level alarm. This can possibly eliminate the need for a trip to the location.

Day to day operations can be streamlined with the remote control capabilities. The time saved by not having to drive to a location will ultimately pay out the initial installation costs. If a compressor a hundred miles away needs to be turned off because of pipeline problems, a phone call to the RTU can accomplish that. If a circulating pump has to be turned on before a tank of oil is run, all it takes is a phone call. If equipment is down, a phone call can push a reset button or start control.

Software

The purchase of software should be approached with the same objective view that designed the scada hardware system. To keep costs down, purchase only what is necessary for current operations. Options that are currently not needed may sound enticing, but if they are never used, the extra cost incurred was wasted. Software continues to change at a rapid pace. When added features are needed, upgrades and new programs may be obtained at a lower cost than the price of the initial options.

There are "super" programs currently available that are compatible with most scada equipment. These programs utilize excellent graphics to exhibit data received and current statuses of equipment. Supervisory control is extremely easy to implement with this type of software. If ease of use is a higher priority than cost savings, this type of software should be evaluated.

Conclusion

The initial cost of equipment can be intimidating to the independent operator. However, by designing a system to specifically meet his needs, payout can be justified by time and cost savings received. Increased efficiency in operating procedures can be obtained by utilizing the information obtained and the supervisory controls made available. These benefits, along with the prevention of costly spills and equipment failures, should be included when justifying the cost of a system.

Definitions

4 - 20 mA Input is a variable DC current that is used to indicate the amplitude of a process function, i.e. temperature, pressure, level, ph, etc.

Accumulator Inputs. Also known as counter inputs are inputs that count and store to memory AC or DC pulses from devices such as turbine meters.

A/D. Analog to Digital Conversion is the process of converting an analog value into a digital value that could be used by a computer. Analog signals, from field instruments, are either unipolar or bipolar, and are further classified as a voltage or current type signal.

Analog Input is a generic term for any input that is a varying signal, i.e. 4-20 mA, 0-10 volts, etc.

Automatic Remote Dialer is a device that monitors conditions at a remote site and, if an alarm condition develops, will alert personnel at other locations. It sends data via telephone or cellular phone.

Baud. Baud rate is the number of signal changes per second on a communication line. Baud rate is frequently, and incorrectly, used as being synonymous to bits per second. Note: A single signal change can represent more than one bit of information.

Control Output. Relay control either non-secure or secure. See digital output.

CPU. A Central Processor Unit is the "heart" of all processor, MPU, microcomputers, and micro-processors. It makes up the logic that fetches and decodes instructions, maintains pointers, counters, arithmetic-logic functions, and handles interrupts. In a more general use the word could refer to the complete Computer device such as a IBM PC excluding the I/O devices.

Digital Input is an input whose voltage level is either maximum or minimum, i.e. on or off.

Digital to Analog Conversion. "D/A" is the process of converting a digital value generated by a computer into a corresponding analog output (eg, volts or milliamps) for output to an analog control device.

Digital Output is an output whose voltage level is either maximum or minimum, i.e. on or off.

End Device is a generic term to indicate a process sensor or actuator, usually any hardware connected to an input or output terminal.

EPROM. Erasable Programmable Read Only Memory is a nonvolatile memory component which can be read but not written by a computer but can be erased and reprogrammed by a "PROM" programmer device.

EEPROM. Electrical Erasable Programmable Read Only Memory is a nonvolatile memory component which can be read and written to by a computer device. Typically used to store unit configuration data, which is modifiable by the end-user.

Firmware. Computer instructions that are embedded in the hardware, stored in PROM, EPROM or EEPROM devices, and is generally not modifiable by the end-user.

Integrated Circuit. A tiny complex of electronic components and their connection produced on a slice of material such as silicon.

Indication Input. Input from some field device that is either in an ON (1) or OFF (0) state. Also known as Status Input or Field Status.

Input/Output is a process of passing data from an external device to a computer or of passing data from a computer to an external device, generally user selectable.

Microcomputer. A computer based on a particular microprocessor. The architecture is best suited to a real-time environment because of its interrupt structure. This device is given an assorted number of names; MPU, CPU and Microprocessor to name a few.

Microprocessor. Subsystem circuit of a microcomputer that performs the sequential manipulation of data

Modem. A MOdulator/DEModulator is a communications device providing an interface point to a communication line. It converts digital data to analog for transmission and analog data to digital for reception.

MPU. MicroProcessor Unit. See microcomputer.

Prom. Programmable Read Only Memory is a memory component which can be read by, but not written by, a computer. The memory contents of this device can be set only once by using special programming device.

Protocol. Set of rules governing message exchange between two communications processes.

RAM. Random Access (Read/Write) Memory is a volatile memory component which can be both written and read by a computer. A computer's main memory is RAM.

RTU is a remote terminal unit located on location and includes the scada controls and communications equipment.

Transducer is a device that converts physical forces, such as pressure, to an electrical signal that varies proportionally with the force changes.

References:

Omega Engineering, "The Data Acquisition Handbook", 1992