Relay Based SCADA Solution

Part 2: System Wide Integration

In a previous issue we discussed how to easily integrate a relay system on a local level. In this issue we tell you how to extend integration system wide. We have used this system for several of our clients and have found it to be highly reliable, cost effective, and quite powerful. The difference between system wide integration and local integration is simple. We want the same information, except we want to bring it to a central location from all of our stations. We do this using Ethernet-based communications.

The convergence of Ethernet-based communication channels, improved software tools, and hardened secure communications equipment has made relay system communications more capable, reliable and less expensive than ever. Ethernet-based integration goes beyond SCADA to support engineering access to protective relays and makes other valuable capabilities feasible.

This system offers distinct advantages over both proprietary SCADA (which only offers real-time data and control), and dial-up engineering access. Ethernet-based integration takes advantage of the channel's ability to support multiple communication sessions, each tasked to support a specific requirement. The technology supports a wide variety of communication channels and protocols and offers a simple method for migrating to new channels and protocols in the future.

System Overview

Figure 1 illustrates the key components of this system for a simple distribution substation. Note that the system is identical to the local integration up to the communications processor. This means that the relay system design for a station with local integration is identical to a system with system wide integration. The flexibility of the communication processor allows this system to be implemented with both local touch screen HMI's and a PC at a central location. This would even allow a utility to implement integration in functional stages. Local integration could be implemented as in part 1 of this series, then Ethernet equipment could be added for system wide integration.

The Ethernet switch is connected to the communication processor twice. One connection supports remote data acquisition by the industrial PC. The other connection supports an engineering access session. The Ethernet switch is connected to a wide area network. Many sites and control center locations may be connected on the network. At each utility control center, an industrial PC is connected to the wide area network. At each site, additional devices can be connected to each switch, including communication processors, digital video cameras, weather stations, etc. Each of the major components in the system is described in further detail below.
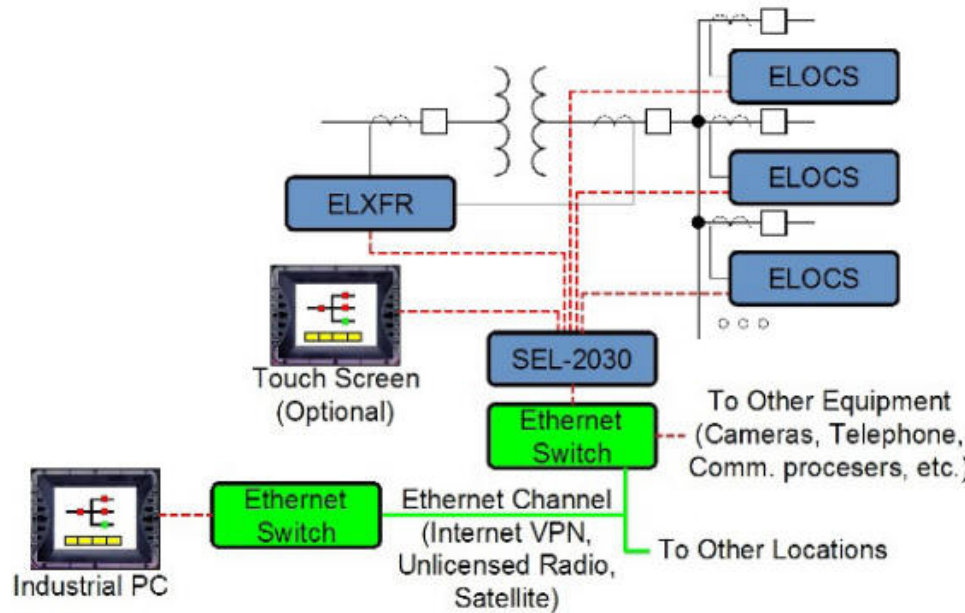
Figure 1: Relay Integration System Overview

Ethernet Channel

Selecting Ethernet to support the system makes a wide range of mature technologies available, plus a few newer ones. Fiber optic connections, in those stations where it is available, offer tremendous bandwidth that is both secure and reliable. A Virtual Private Network (VPN) established over the public internet can be made secure and is relatively inexpensive. Several styles of Ethernet radios are now available in licensed and unlicensed frequencies. These radios typically operate line-of-sight, with a range from 2 to 60 miles. Some models support multiple hops between stations through the use of repeaters. Bandwidth ranges from 115kbps to 8+Mbps. For remote sites, satellite digital communications are now available.

Ethernet Switches

Hardened Ethernet switches connect communication processors and other devices to the wide area network. Ethernet switches allow any Ethernet-capable device to be connected to the network. Further, many legacy devices can be connected through adapters. Several dual-redundant communication topologies are feasible using a combination of Ethernet switches, without incurring the access complications and performance penalties of a two-tiered communication processor approach.

Software Architecture

The software components located on the PC must be able to expand as the system grows without major upgrades or modifications. Figure 2 shows the architecture of the PC software.
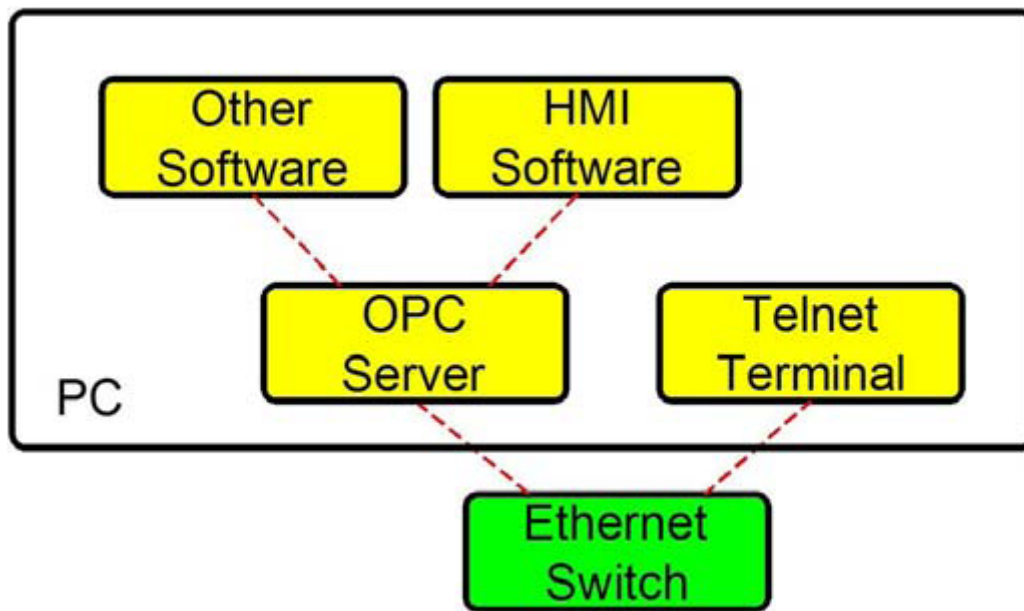
Figure 2: Software Architecture of an Ethernet Based SCADA System

One of the key components is the OPC Server. OPC (OLE for Process Control) is a defined set of interfaces, based on OLE/COM and DCOM technology, for truly open software application interoperability between automation/control applications, field systems/devices and business/office applications. Basically the OPC server collects data from the communication processor or other IEDs and makes it available to any other application located on the PC or connected LAN.

The OPC Server can use a variety of protocols to communicate with the communication processor. One powerful aspect of an OPC server is that a single server can communicate with multiple devices using different protocols all while making the data available in a single location. An intuitive user interface (HMI) is key to the success of a SCADA system. The HMI software must provide the tools necessary to efficiently implement a user interface that offers all the features of a traditional SCADA system, plus a convenient way to move beyond the basic functions into less traditional areas.

Since the relay data is available in the OPC Server, any number of OPC compatible software applications can be run on the PC to accomplish specific tasks. A great example of this is alphanumeric paging. The paging software can be set up to monitor digital alarm bits in the OPC server. When one of those bits asserts, the software can compile a custom page based on analog and character data also available in the OPC server to alert utility personnel of the alarm. Data historians, alarm logs, graphic data presentations and mapboard controls are all available to use data from the OPC server.

Things to Consider

The first thing to consider when approaching an Ethernet-Based SCADA system is channel availability. Direct fiber, Ethernet radios, and VPN over the public internet (i.e. cable, DSL, satellite) are all options to consider. Typically, at least one of these will be available at the site. Other things to consider are include:

- Availability of microprocessor based relays and communication processors.
- Inclusion of other IEDs into the system (i.e. voltage regulators, transformer temperature sensors, load tap changers)
- Paging, email, or other notification methods
- Local versus remote HMIs
- Desirability of substation video support
- Inclusion of substation telephone capabilities

Bringing It All Together

Perhaps the most exciting aspect of these new technologies is the price. These powerful hardware, software, and communication tools are now available in a price range that places them within reach of smaller utilities. The software architecture makes the system protocol-flexible so remote terminal units, PLCs, and protection communication processors can be supported by a single HMI. The system can be efficiently developed in stages as communication channels become available or protocols change. Modifications can be made easily as substations or the electrical system requires. And the open architecture and powerful software features make it possible to solve new problems, perform new functions, and take integration to a new level.