INTERNET BASED FLARE AND LFGTE FACILITIES REMOTE MONITORING AND CONTROL

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A BRIEF HISTORY OF CONTROL SYSTEMS

The first control systems were comprised of an operator, analog gauges, and level indicators. Any adjustments to the system were manually made by the operator and data was collected using Sneaker-Net[1]. As technology advanced, PLC's[2] were introduced that could not only control the system, but also display the data in real-time on PCs. To accomplish this, many of the PLC manufacturers developed proprietary networks based on industry standardized serial networks.

Today, modern control systems use a mixture of wired-Ethernet and WIFI networks for control and to collect data. Many of these systems are designed to operate unmanned and continuously adjust system components to maintain the desired output: power, landfill gas (LFG) flow, or landfill wellfield vacuum.

WHAT IS INTERNET REMOTE MONITORING AND CONTROL?

Internet Remote Monitoring and Control (IRMC) or internet SCADA[3] (iSCADA) is the ability to control a site from anywhere in the world using the internet as the connection media. From a remote location, the operator has full control of the system. They can start or stop the system, reset alarms, and make set point changes. The operator has the same control capabilities standing in front of the local control panel or 3,000 miles away on a web browser. Figure 1 shows a web browser connection to a remote site, via the SCS iSCADA system.

The iSCADA system uses a secure connection[4] to allow the operator to view and control the system over a web browser. The operator simply types the name of the site with the .scseng.com extension and the connection is initiated. After entering the correct username and password, the connection is made. The addresses of the sites are setup on the SCS DNS[5] server so that the operator does not have to remember the IP addresses (65.168.98.142 = www.scseng.com). This allows any SCS operator or technical support staff member to use any PC/MAC with a web browser to connect to the site.

SITE CONFIGURATION

The systems designed and installed by SCS Energy (SCS) are based on the philosophy of minimizing operating labor. For small facilities, such as microturbine facilities smaller than 500 kW, one operator can run five or more sites. This allows the operator to visit each site at least once a week, while still allowing time to check each site on a daily basis. Typically the operator will visit a site and remotely check on the other systems from the site they are visiting. Since the sites are not visited on a daily basis, the systems are designed to be unmanned-fully-automated systems. Larger sites, such as those with one reciprocating engine, can be operated on a part-time basis. Nighttime and weekend callouts can be minimized at large, fully-staffed sites.

Figure 2 shows the site network topology. It depicts the major control system components: (1) the PLC, (2) two PCs, and (3) the networking equipment. As shown in Figure 2, the control system is comprised of the networking equipment, a PLC and two PCs.

The first component of the control system is the networking equipment. The most important device in the networking equipment is the Ethernet switch. It allows the

[1] Sneaker-Net: The operator, who is wearing sneakers, walks around with a clip board, recording system parameters.
[2] PLC: a Programmable Logic Controller is highly specialized and dedicated computer. It performs a precompiled program hundreds of times a second.
[3] SCADA: Supervisory Control And Data Acquisition.
[4] The secure connection uses a 128-bit encryption scheme. This is the same level of encryption used by banks.
[5] DNS: Domain Name Server. The Domain Name Server resolves the name of the web site with the IP address of the server that will send the requested information from that web site.

PCs and PLC to communicate locally. The VPN[6] router and the internet modems (DSL, CABLE, and SATELITE) are only used when accessing the internet or when a remote connection is made into the system from the site operator or technical support personnel.

The second component, the backbone of the control system, is the PLC. It collects data from individual sensors and controls all critical system components. The PLC is programmed to continuously adjust individual system components (louvers, blower speeds, valve position, and power output) to maintain the desired output. If a system parameter exceeds safe operating conditions, the PLC stops the system/process and alerts the operator using a phone-line based call out system. The PLC also continuously collects data from the process and passes this information to the PCs. This is primarily accomplished using the Ethernet network. Serial connections between the PLC and the PCs may be used, depending on the age of the system.

The third component of the control system is the PCs; they are the windows into the process. They allow the operator to view and modify the process set points. The two PCs are configured to run Windows 2000 or XP Pro based operating systems. The PCs are configured as a data logger (LOGGER) and Human Machine Interface (HMI). Each unit is loaded with specific software that is designed to collect and record, or simply present the data in real-time to the operator.

The LOGGER PC contains one or more PLC communication-server software that is supplied by the PLC manufacturer. The software communicates with the PLC every few seconds and holds the data in memory. The Wonderware Software then retrieves this data and stores a copy in a Microsoft SQL Server[7] database and forwards another copy to the HMI computer. The data is transferred to the HMI PC over the Ethernet connection using a controls communication protocol such as SuiteLink[8]. The Wonderware software installed on the HMI PC receives the data, processes it, and renders graphics using the data. Finally the Web Viewer application converts the graphics rendered by the Wonderware software into JAVA enabled html; the language of the internet. Figure 3 depicts this process.

Using a Web Viewer application to convert the graphics allows the control screens to be accessible from JAVA enabled browsers. Historically this has been limited to PCs, but many new smart phones are coming equipped with stripped down JAVA enabled web browsers. In the very near future, these phones will likely fully support a PC based JAVA web page. When this support is fully realized, the operators will be able to view and control the sites from anywhere in the world, on their cell phone.

HOW IS ISCADA POSSIBLE?

Several things have made iSCADA possible: (1) the ubiquity of high speed internet; (2) the adoption of Ethernet based control systems; and (3) the significant cost reductions in networking equipment. In the early days of the internet, connection speeds were very slow and access to the internet was limited to a dial-up phone connection. Today many shops, airports, hotels, and public places offer free internet access. This is due to the fact that networking equipment costs have dropped in price, allowing businesses to purchase equipment relatively inexpensively. SCS has equipped many of its field personnel with cellular based internet cards, so that they can access our sites from anywhere.

The adoption of Ethernet based control systems has allowed system SCS to easily and inexpensively integrate systems that span many miles and many locations, into a unified SCADA system. Figure 4 depicts an application designed and installed by SCS that spans several miles, uses five operator interfaces[9] at five distinct locations. Four of these locations are locations of operating equipment and the fifth is a "control room" in the client's headquarters office (M12). A communication cable was installed in the same trench as the landfill gas conveyance pipeline. Each location houses an operator interface that allows the site operator, to remotely monitor and control the entire system. For example, the operator can make set point changes to M3 from the M12 facility. The operator also has the ability to remotely monitor and control the system from anywhere using a high speed internet connection and the company laptop.

In the past, this type of system would not have been possible. The project is now a reality because of low network equipment costs and the high network connection speeds. Although this type of system is now technically possible, many designers would still have designed this SCADA system as four separate systems[10]. Each system we be configured to use dial-up based communications.

[6] VPN: Virtual Private Network. A VPN is a private data network that makes use of the internet while maintaining privacy through the use of a tunneling protocol and encryption.

[7] Microsoft SQL Server is a Relational Data Base Management System (RDBMS) from Microsoft Corporation. It is designed for client/server use and is accessed by using queries from client machines formatted in the SQL language.

[8] SuiteLink is a TCP/IP based protocol. SuiteLink plays the role of adding the time stamp and a quality flag to the acquisition data value.

[9] Operator interfaces (HMI) are located at: one at Pretreatment, two at M12, one at M3, one at M5.

[10] One system would have been located at Pretreatment, M12, M3, and M5.

The operator would have to call up each location to check its status, disconnect, and then call up the next location. The operator would continually do this all day.

REMOTE DIAL-UP VERSUS HIGH SPEED INTERNET

Using a dial-up connection to check the site status is nothing new. Many companies have been using remote dial up systems for many years. These dial up systems fall into two categories: (1) a PLC based control system with limited capabilities and (2) a complete control system with limited remote capabilities.

The PLC based control system is usually comprised of a PLC with a modem and a local control panel. A remote PC running proprietary software, usually located at an office, is configured to call up each remote location. Depending on the SCADA system, the operator can sometimes view a real-time trend of the data, but most systems do not allow the operator to view historical data. These types of SCADA systems are very inexpensive and offer fast refresh rates, but do not allow the operator to view historical data. Instead they force the operator to log the data on paper (a hybridized Sneaker-Net control system) and require that reports be created by hand inputting spot check numbers. Because of the limited amount of data, the system performance can never be analyzed, significantly hindering troubleshooting and extending downtimes.

The second type of dial-up system requires a PLC and one or more PCs with a modem at the remote site. This system allows the operator to use any PC with a modem to call into it. In these systems the operator uses PC Anywhere or some other type of remote control software to view and control the system. These systems are typically more expensive than the first type of dial-up systems, but allow the operator to call-in from anywhere and also allow the operator to view historical data. Reports are created from the stored data and allow the system performance to be analyzed, reducing downtime, and allowing engineers to recommend set points changes that result in improved system performance. One downside to this type of system is that it requires continuous PC maintenance. Since the PCs use a windows based operating system, Microsoft and antivirus updates are required on a weekly basis. Some companies erroneously believe that these updates are not necessary. However, many of the systems are accessed by site operators and engineers and whenever data is retrieved from the site, floppies or flash drives are used. These can carry virus' that can potentially result in data loss.

SCS installed this type of dial-up SCADA system, for the County of San Diego, approximately three years ago. This SCADA system incorporates 10 flare stations and a microturbine LFGTE[11] facility. This system also includes full historical data storage, historical trending capabilities, and limited remote capabilities. Although flare sites require less operator intervention than power plants, the enhanced data storage and remote retrieval capability have proven to be a significant benefit.

Although both dial-up based systems are less expensive and easier to install, iSCADA systems are easier to operate and maintain. The higher internet connection speeds allow multiple connections to the site. This permits several users to be connected at the same time. SCS has been able to troubleshoot issues while two or more users were connected to the system from multiple locations throughout the U.S. The always-on internet connection also allows the PCs to be configured to automatically receive Microsoft and antivirus updates, significantly reducing PC maintenance costs. SCS recently installed internet connectivity to a dial-up remote site and found that the labor required to perform the PC maintenance was reduced from 7 to 10 hr/month to less than 2 hr/month. The internet connection also allows the operators to routinely check the site at all hours.

SCS is presently operating a 7.5 MW power plant in Sun Valley, California, and the site operators routinely and simultaneously check the site from home, the SCS corporate office, and anywhere they have internet access. This has resulted in less frequent and shorter downtimes. See Figure 5 for a screen shot of the application main screen.

The high speed connection has also allowed SCS to continuously upgrade the SCADA applications installed at the remote sites and has given SCS the ability to make minor PLC logic changes remotely. This has significantly lowered our operating costs, because programmers (PLC and HMI) are no longer spending several hours traveling to the site to troubleshoot a simple problem. They can connect from anywhere, identify the problem and make program changes if necessary. This capability has helped to reduce the duration of downtimes.

Although the use of high speed internet connections provides many benefits, there are several downsides. The biggest downside to iSCADA systems are the heavy reliance on the internet connection. It is the lifeline to the site and if it fails, then the operator must use a dial-up based system to remotely check the site. Internet outages have become less frequent and shorter in duration, making this less of an issue. The second downside is the cost of the internet connection. This can range in price from $99 to $499 installed plus another $99/month. Although more

[11] LFGTE: Landfill Gas To Energy

expensive than a traditional phone line ($35/month), the higher connection speed allows for reduced operating costs, offsetting the cost difference. The third downside is that an operator can use the site internet connection for nefarious uses. If the site is not properly managed by information technology personnel, the operator could view questionable material or illegally download unlicensed content.

Internet enabled SCADA solutions allow companies to lower operating costs while still providing quality service and support. iSCADA has allowed SCS to extend its service and support capabilities from California to New Jersey. The future of service and support will be internet based technology. Today, many control manufacturers are already designing systems that will be able to communicate and send data across the internet. This will allow companies that have sites spread across the country to be controlled from a single SCADA application. As technology advances the next wave of cellular phones will allow these SCADA application to be integrated into phones, allowing operators and technical support personnel to be able to control the systems from anywhere in the world.

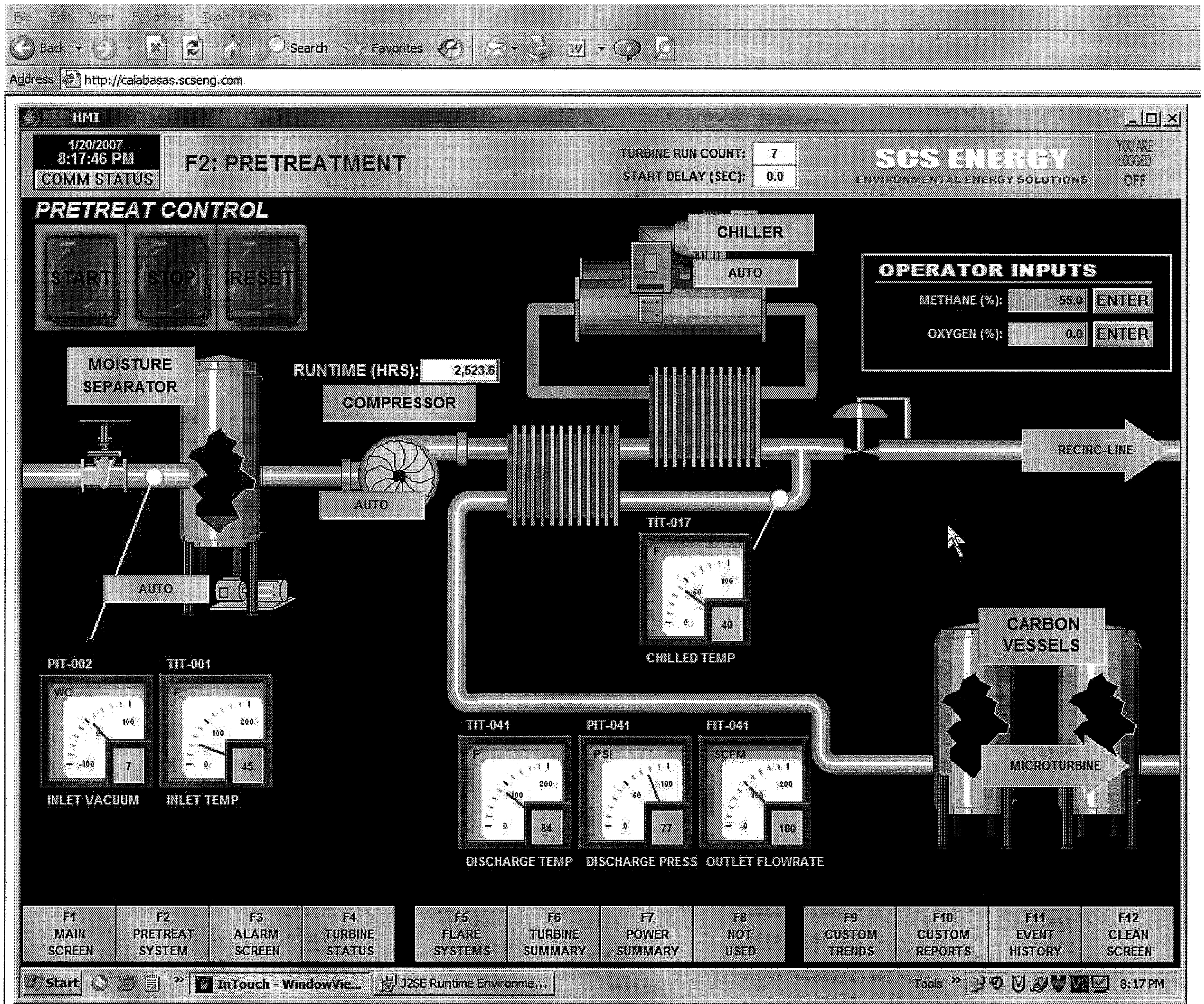

FIGURE 1: SCS ISCADA RUNNING ON INTERNET EXPLORER 6 WEB BROWSER.

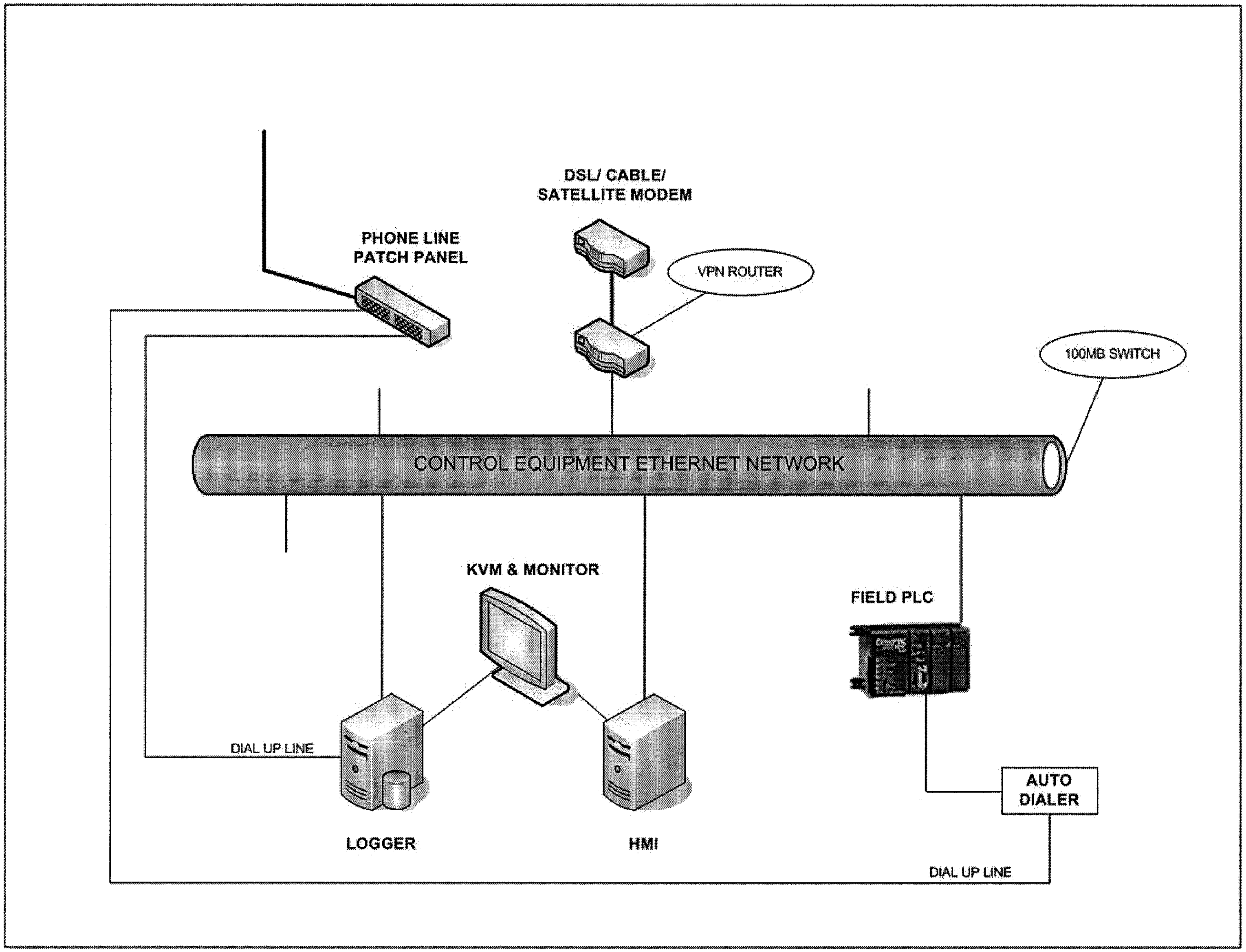

FIGURE 2: CONTROL SYSTEM NETWORK TOPOLOGY

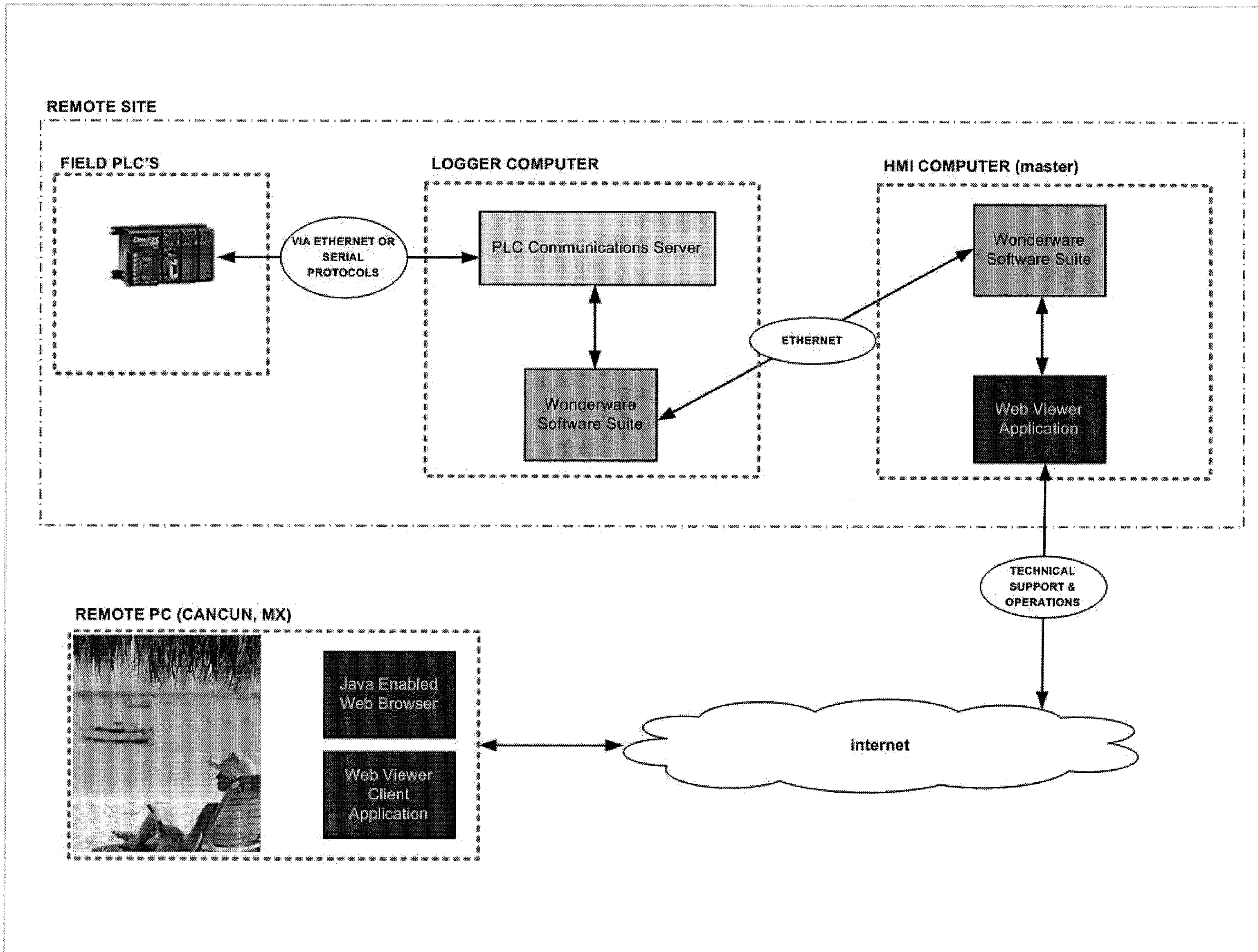

FIGURE 3: CONTROL SYSTEM DATA FLOW DIAGRAM

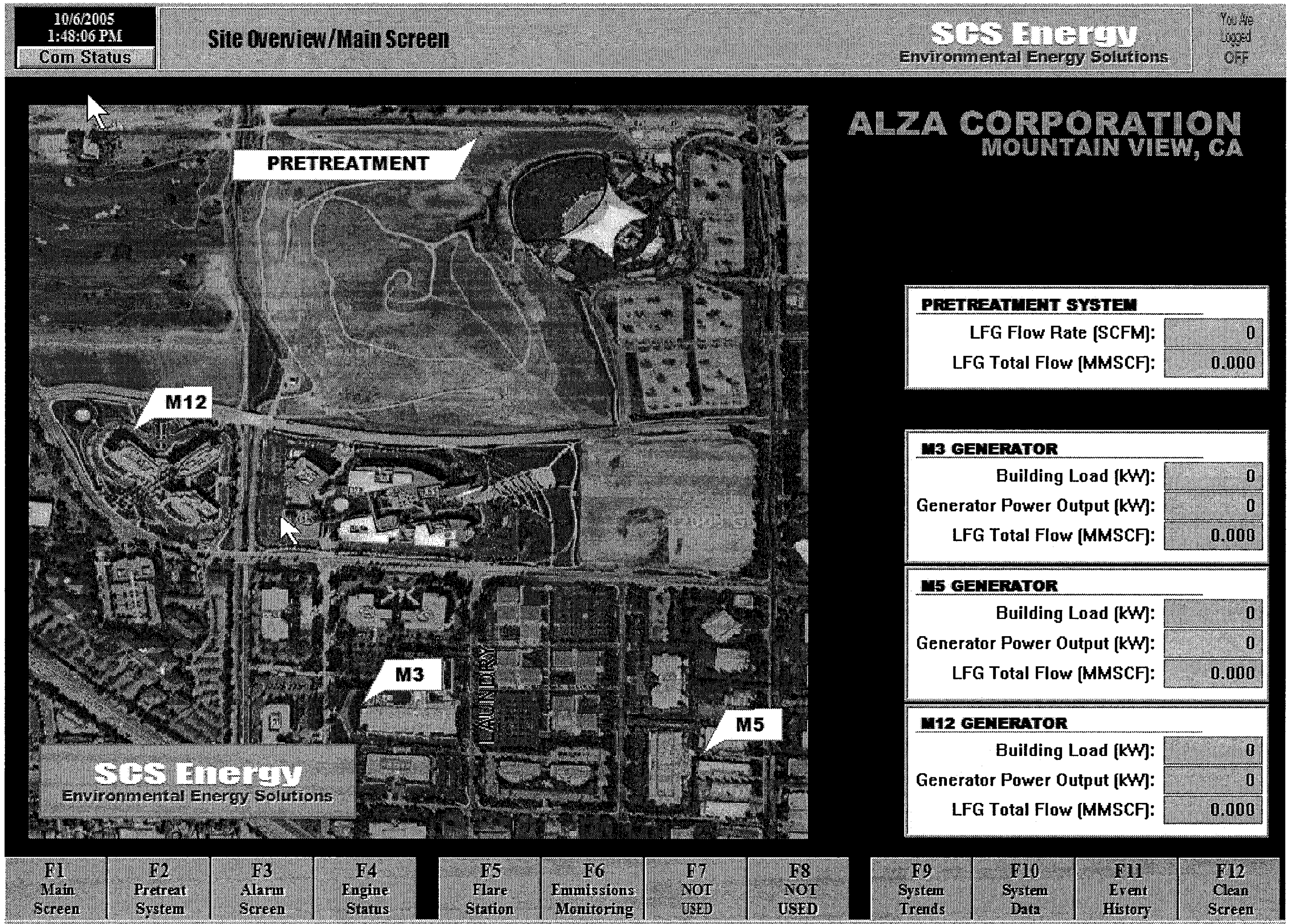

FIGURE 4: REMOTE ETHERNET BASED CONTROL SYSTEM

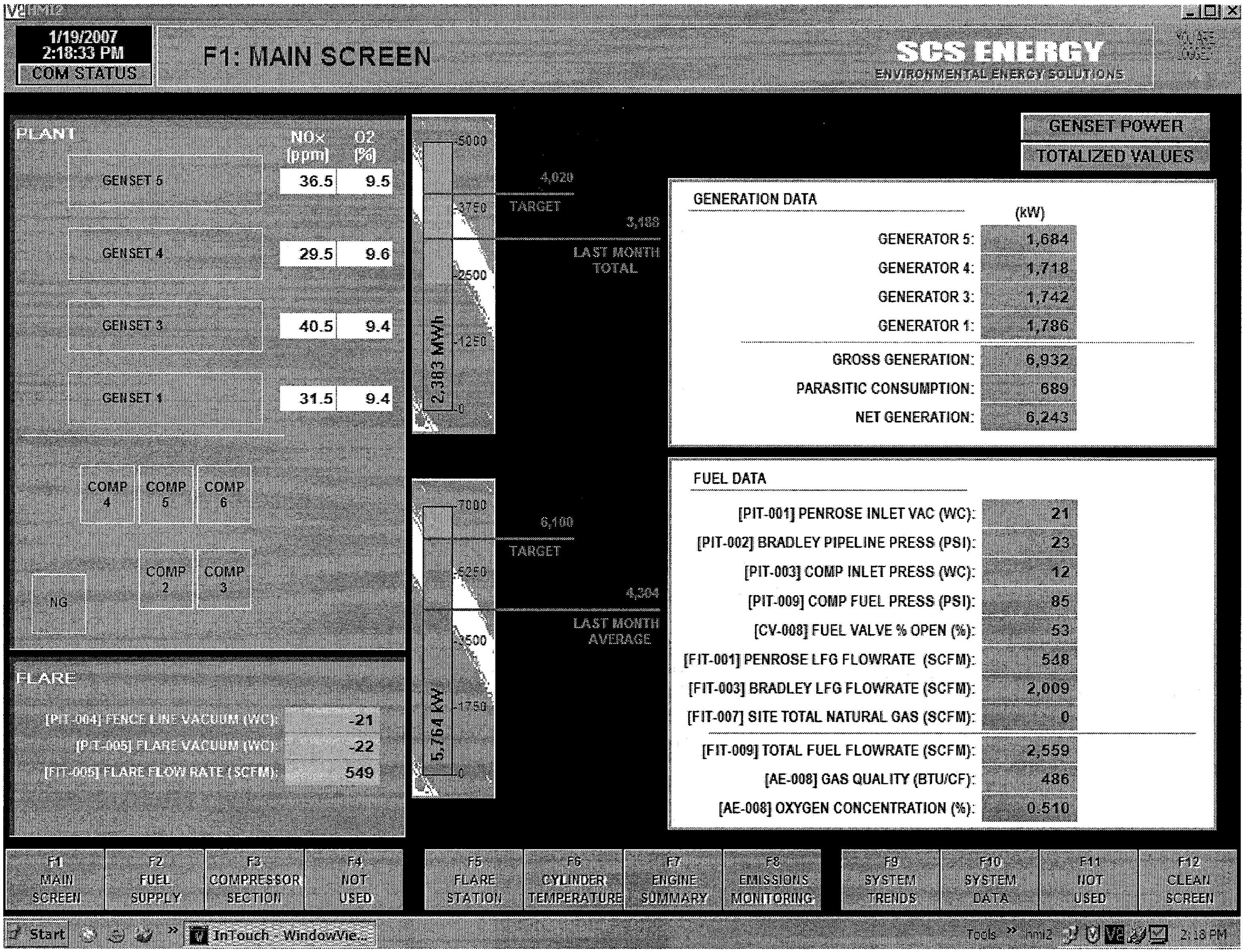

FIGURE 5: APPLICATION MAIN SCREEN