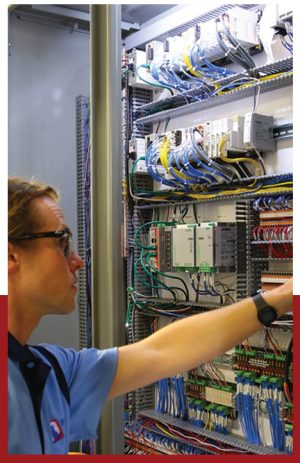

Case Study: Natural Gas Fueling Stations Communications

Spanish integrator Optomation Systems improves enterprise communications

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CASE STUDY: NATURAL GAS FUELING STATIONS COMMUNICATIONS

Spanish integrator Optomation Systems improves enterprise communications

Worldwide, the use of natural gas and hydrogen as a fuel source for vehicles doubled in the eight years between 2003 and 2011. Improvements in automotive engine design, combined with the lower production cost of natural gas (compared to heavy diesel fuel), made use of natural gas vehicles (NGVs) more attractive and cost feasible—particularly for public transportation. Also, the environmental benefits of using NGVs in urban areas are quite substantial. These benefits include a reduced dependence on fossil fuels and a reduction in greenhouse gases and other emissions.

Currently, densely populated and gas-rich countries like Argentina, Pakistan, and India have the largest number of NGVs on the road, but other nations are catching up quickly—beginning with their public transit systems. Onboard natural gas storage cylinders can be easily incorporated into buses, trams, and other large vehicle designs, making NGVs highly practical for these types of fleet operations.

REDUCING MADRID'S AIR POLLUTION

Like many large cities, Madrid is seeking to improve its air quality. Studies indicate that municipal buses and taxis contribute to the city's air pollution problem. With 426 million passengers riding the city's fleet of 2100 buses each year, any environmental decision made by Madrid's Municipal Transport Company (EMT) directly affects the quality of air in Spain's capital city.

In a bold five-year mission, Madrid is aiming to replace or retrofit its diesel buses with CNG (compressed natural gas), LNG (liquefied natural gas), and electric powered vehicles by 2016. Early results from this undertaking have proved quite promising. As of 2011, 465 natural gas-powered buses have been introduced in Madrid. This represents an annual reduction of 54 tons of nitrogen oxide/dioxide (NOx), 4 tons of suspended particles, and lower CO2 emissions.

But before the huge step of replacing Madrid's entire diesel bus service with gas-powered vehicles can be made, the necessary infrastructure needs to be in place. More specifically, suitable gas refueling stations need to be built.

THE SANCHINARRO DEPOT: "ECOLOGICAL BUSES ONLY"

One of the advantages of NGVs is that they can be refueled simply by tapping into existing (and abundant) natural gas lines. The Madrid city government, in a joint venture with Gas Natural-Fenosa, Spain's leading gas company, has invested $47 million dollars in a custom refueling station and parking depot for 300 natural gas-powered buses in the Sanchinarro area of Madrid. Four additional stations are being built along the outskirts of the city. As these are completed, obsolete diesel fuel stations can be sold off as prime real estate, thus providing additional financing for this project.

Using the latest high-speed filling technology, the nine lanes of the Sanchinarro fueling station can refuel 180 buses per hour, equaling the throughput of a diesel station. A separate area allows fueling of other municipal NGVs, such as refuse trucks and ambulances, as well as taxis and private vehicles.

Designed and constructed by the HAM Group, a Spanish company specializing in gas installation projects, the Sanchinarro station includes numerous subsystems and a variety of fuel-related equipment that all need to work together and communicate to keep the station operating safely and optimally.

The Sanchinarro Depot

Many automation engineers would attempt to integrate disparate systems, equipment, and databases, and share that information through a combination of programming, multiple PCs, interface cards, and relational database applications. However, when dealing with industrial applications that require real-time data, these kinds of solutions are often just not fast, stable, or reliable enough.

Furthermore, the cost of ownership for these types of solutions is very high, as one or more full-time, experienced programmers and/or communications specialists must be retained and on-call in order to maintain the cobbled-together system.

OPTO 22'S SNAP PAC SYSTEM

An Ethernet-based industrial automation, data acquisition, and communications system—based on Opto 22's SNAP PAC platform and implemented by local integrator Optomation Systems—serves as the communications backbone that keeps the Sanchinarro station operating efficiently. The system employs a number of industrial and IT protocols, including FTP, SNMP, OPC, Modbus/TCP, and M-Bus to communicate more than 600 different data values to and from the Sanchinarro station's equipment, systems, and external databases.

"With traditional PLCs, communication to third-party systems is usually something available as a limited add-on," says Rafael Hernandez, Senior Project Engineer at Optomation Systems. "But the SNAP PAC programmable automation controllers have amazing Ethernet TCP/IP connectivity. You can open multiple sessions to any IP node on a local or remote network to access and exchange data with a variety of other machines, computers, and business applications, without worrying about their different operating systems, software, or program versions."

"With traditional PLCs, communication to third-party systems is usually something available as a limited add-on. But the SNAP PAC programmable automation controllers have amazing Ethernet TCP/IP connectivity. "

- Rafael Hernandez, Senior Project Engineer, Optomation Systems

Compressors

The gas compressors used at the Sanchinarro station have their own local controller and control panel. The SNAP PAC system opens simultaneous Ethernet sessions with the master compressor and nine distributed compressors—one for each station lane. Through these links, detailed operational and maintenance-related data on each compressor is aggregated and communicated to the SNAP PAC controller via the Modbus/TCP protocol.

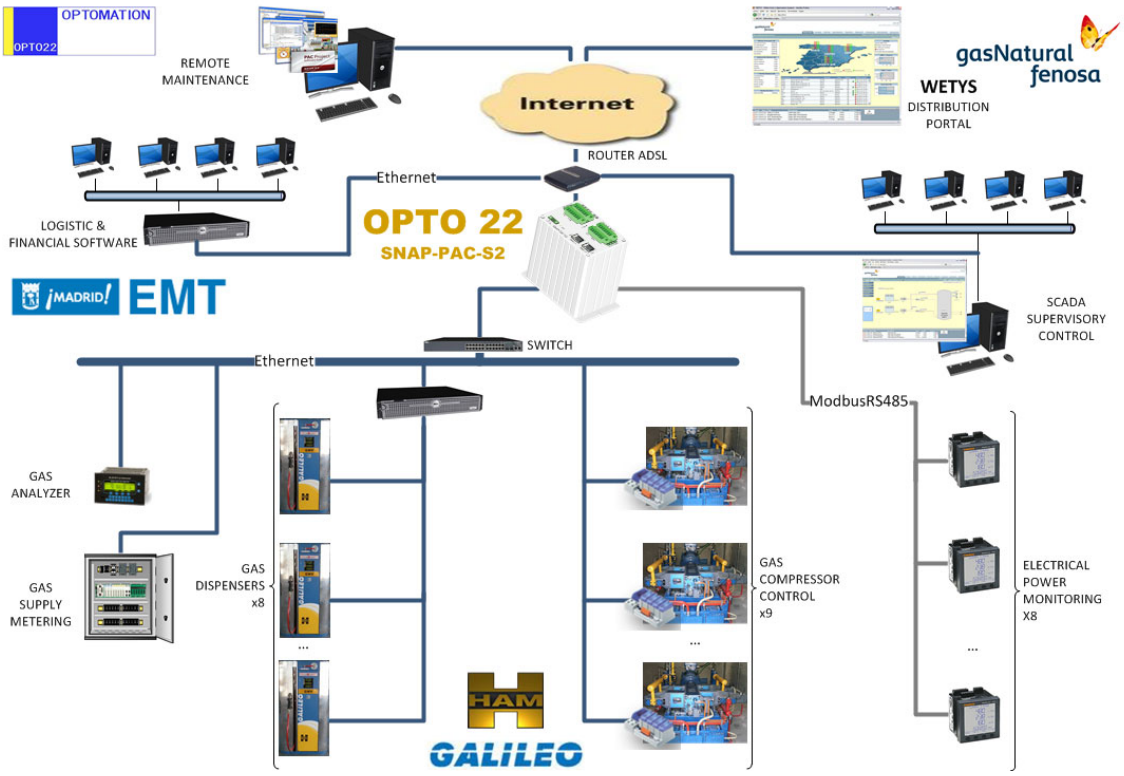
NGV Fuel Dispenser

Fuel Dispensers

Sanchinarro utilizes sophisticated mass-flow compressed natural gas fuel dispensers manufactured by GNC Galileo S.A., an Argentine company specializing in compressed natural gas and related technologies. The SNAP PAC system acts as a communications gateway or "message broker" to and from these dispensers. In this role, the SNAP PAC passes information in an ASCII format between the centralized EMT servers and the fuel dispenser server. The PAC also transmits real-time messages and data (such as individual transaction details and vehicle license plate numbers) so EMT can properly reconcile, validate, and bill anyone fueling at the station.

Power Meters

The SNAP PAC system also integrates data from eight distributed power meters from Schneider Electric, which are used to monitor the station's electrical consuming equipment and provide data for power quality analysis,



PAC System Architecture Diagram

energy management, and load preservation. The data is also used for sub-billing, cost allocation, and utility bill verification. Communication takes place using the Modbus protocol over a standard RS-485 connection.

Gas Metering and Chromatograph Equipment

The SNAP PAC system offers protocol support for a wide range of industrial gas metering systems, including the gas flow and analysis equipment at Sanchinarro. Chromatograph information and statistics on gas quality and purity are aggregated by the SNAP PAC and made available to IT systems on authorized and secure Ethernet networks. Data and variables include corrected gas flow measurement; percentages of methane, propane, butane, and trace gases present; along with temperatures, pressures, and densities. This data is also routed to Gas Natural's billing servers located in Barcelona.

WETYS

Gas Natural operates its own business management system, the Web Based Telecontrol and Supervision Energy Portal (WETYS). The system is used to track and analyze all of Spain's energy gas distribution, supply, and consumption in real time. Intelligent devices deployed in installations across the country communicate data using a secure transaction protocol combined with standard Web-based protocols.

The SNAP PAC system communicates using these same protocols, so by simply adding a dedicated, firewalled Internet connection, the station's production data can be sent securely and directly to the WETYS management system without the need for middleware or software development of any kind.

Hernandez says that Opto 22 SNAP PAC systems are well known for their distributed control and monitoring features, but their advanced communications and networking capabilities are sometimes overlooked.

"Applications like this EMT project require simultaneous communication using a number of different protocols, both industry standard and proprietary. Our job here at Optomation is to design and implement a system that connects everything together and extracts the data that every other system involved needs to have in real time. In

short, we connect technologies, and the Opto 22 platform lets us do that."

FUTURE PLANS

For Alberto Ruiz-Gallardón, Madrid's longstanding mayor, EMT's conversion to natural gas vehicles and its subsequent investment in the fueling stations and other infrastructure to supports these NGVs, makes a lot of sense, both environmentally, economically and politically.

"Any ecological policy represents an expense, but the public understands the cost of not implementing a suitable green policy will be even more expensive in the near future. In Spain, the price of diesel fuel continues to increase at a higher rate than natural gas. Buying diesel-powered autobuses is no longer justifiable by any responsible city administrator."

EMT plans to increase its NGV fleet to about 800 vehicles (representing about 40% of its total fleet) by the end of 2011. Supporting these vehicles will be the refueling stations in Sanchinarro, plus new stations now under construction in the districts of Entrevias and Carabanchel.

Optomation is implementing comparable SNAP PAC-based communications systems for these locations, as well as for similar natural gas fueling station projects now underway in Barcelona, Valencia, and Girona.

"Today, data availability and communications are just as important as things like I/O scanning speed or price per I/O point," says Hernandez. "The Opto 22 architecture supports both wired and wireless network interfaces simultaneously, redundant processors, and redundant Ethernet network links.

"We can communicate directly with the Internet and add the intelligence to buffer, post or reroute the data whenever and wherever necessary, without user intervention. This allows us to simplify and resolve technological problems in ways that are just not possible with other industrial systems."

The Sanchinarro station designed for the Municipal Transport Company of Madrid is now one of the largest refueling stations in Europe.

Currently serving more than 300 natural gas-powered buses, the award-winning facility was recognized by Madrid's mayor, Alberto Ruiz-Gallardón, as integral to "helping citizens on their way to a more sustainable future."

Currently, the facility is the largest compressed natural gas refuelling station in Europe.

It also includes a number of other energy-saving features, such as use of solar power as an electrical power source, and the collection of all residual waters to feed a purifying plant that then recycles the water for use in the bus washing area.

ABOUT OPTOMATION SYSTEMS

Working from its centralized offices in Madrid, Optomation Systems has been the exclusive distributor for Opto 22 for Spain, Portugal, and North Africa since 1996. The company is responsible for the commercialization, distribution, installation, and after-sales support of Opto 22 products in these geographical areas.

Optomation has developed a complete support network, including integrators, consultants, installers, and suppliers that offer services, local support, compatible technologies, and products that complement those of Opto 22.

ABOUT OPTO 22

Opto 22 was started in 1974 by a co-inventor of the solid-state relay (SSR), who discovered a way to make SSRs more reliable.

Opto 22 has consistently built products on open standards rather than on proprietary technologies. The company developed the red-white-yellow-black color-coding system for input/output (I/O) modules and the open Optomux® protocol, and pioneered Ethernet-based I/O.

In early 2013 Opto 22 introduced *groov* View, an easy-to-use IoT tool for developing and viewing mobile

operator interfaces—mobile apps to securely monitor and control virtually any automation system or equipment.

Famous worldwide for its reliable industrial I/O, the company in 2018 introduced *groov* EPIC® (edge programmable industrial controller). EPIC has an open-source Linux® OS and provides connectivity to PLCs, software, and online services, plus data handling and visualization, in addition to real-time control.

All Opto 22 products are manufactured and supported in the U.S.A. Most solid-state SSRs and I/O modules are guaranteed for life.

The company is especially trusted for its continuing policy of providing free product support, free training, and free pre-sales engineering assistance.

For more information, visit opto22.com or contact **Opto 22 Pre-Sales Engineering**:

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