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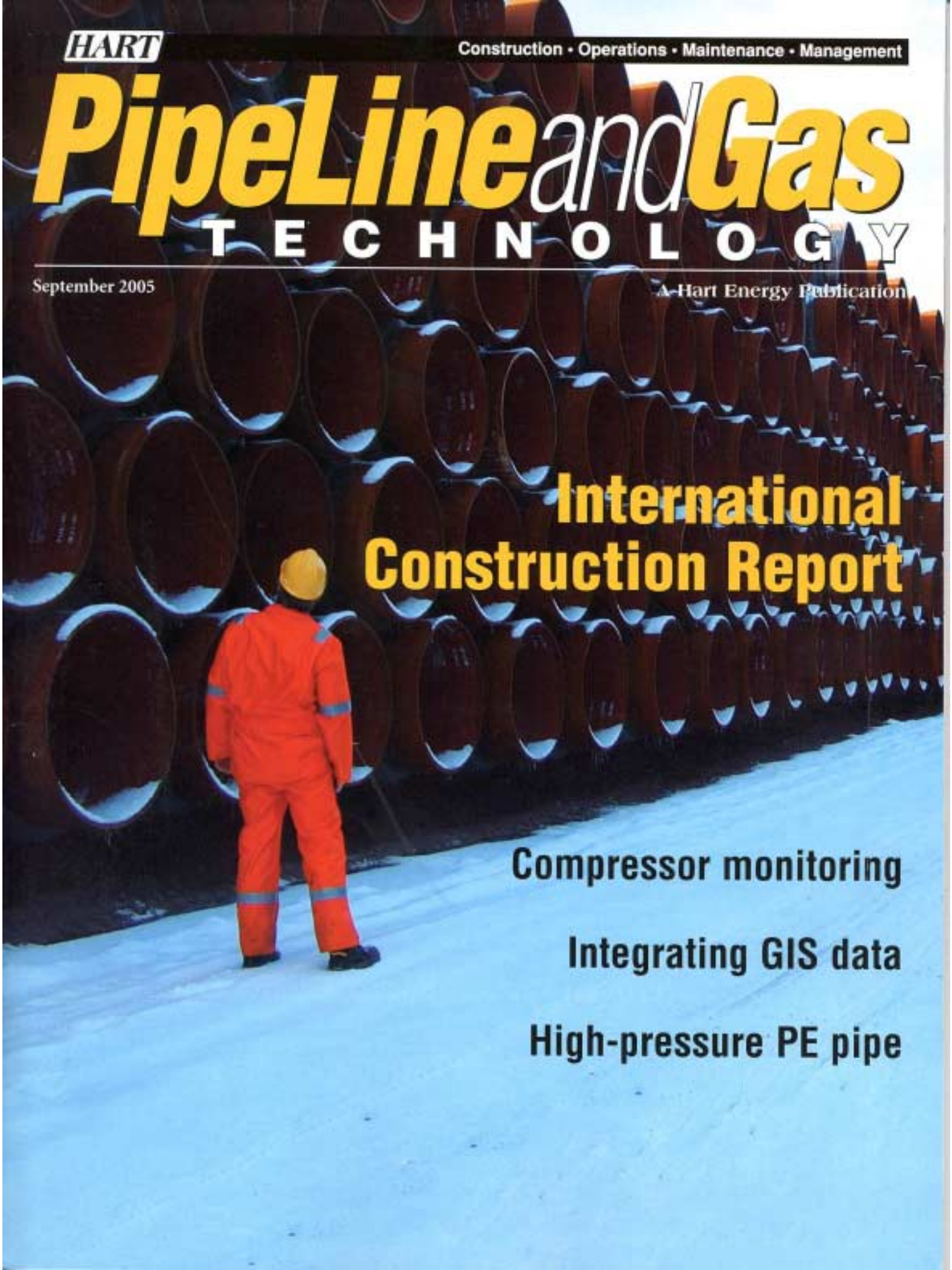


International Construction Report

Compressor monitoring

Integrating GIS data

High-pressure PE pipe

Web offers SCADA alternative

Internet-based systems enable operators to perform remote compressor starts/stops, access real-time data.

Donald I. Wallace,
M2M Data Corp., Denver, Colorado

Internet-based SCADA systems offer a cost-effective and secure alternative to traditional proprietary SCADA. Although the technology is relatively new, it is available from many suppliers, and is being adopted by major oil and gas businesses.

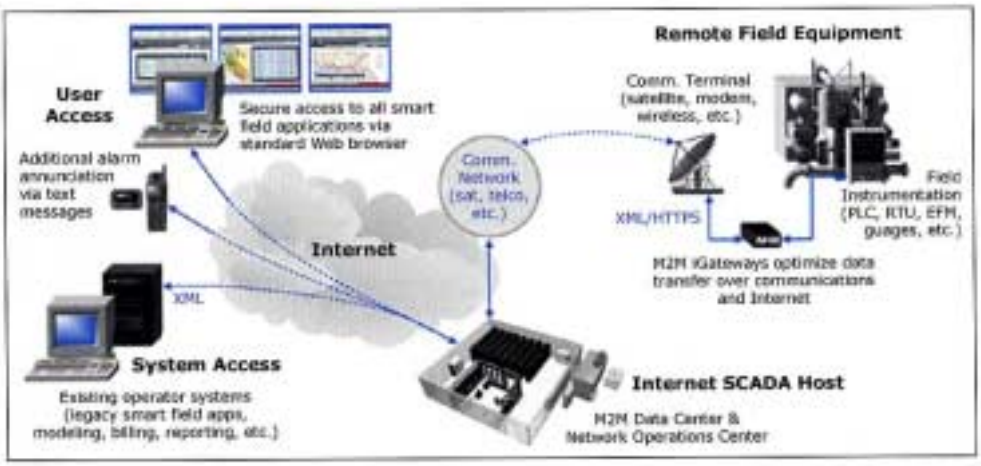
Using an application service provider to implement an Internet SCADA system allows users to gain the benefits of remote monitoring and control (improved efficiency and customer service through increased uptime), without having to commit the human and financial capital normally associated with a traditional SCADA project. The goal here is to provide a case study to describe the technology, and its benefits.

Internet-based SCADA

Using the Internet as the basis for a cost-effective enterprise SCADA system has finally moved from promise to reality. The demand for affordable monitoring and control of remote oil and gas assets is exploding, and many companies are now considering using Internet-based SCADA systems to provide access to real-time data display, alarming, trending, and reporting from wells, tanks, compressors, valves and pipelines.

Sometimes referred to as man-to-machine, machine-to-machine, or mobile-to-machine networks, Internet SCADA systems enable oil and gas companies to monitor, manage and operate equipment more reliably and more efficiently with fewer trips to the field.

Using the Internet makes it simple to use standard Web browsers for data presentation, thus eliminating the need for proprietary host software. It may also eliminate the cost and complexity of long-distance communications, because each piece of remote equipment is connected to an Internet Point of Presence (IPP or ISP). However, actually achieving these benefits through the implementation of an Internet SCADA is fraught with problems that require the attention of experts in the field.



Internet-based SCADA systems can reduce the cost and complexity of long-distance communications, because each piece of remote equipment is connected to an Internet Point of Presence (IPP or ISP).

Implementation challenges

There are three significant challenges to overcome when implementing an Internet-based SCADA system. The first is that most devices used to control remote equipment and processes such as gas production compressors do not have Internet communications capability already incorporated in their operating systems. In fact, many do not even have an electronic controller, let alone an operating system.

The second is that even when equipped through retrofit or in the factory with the necessary communications protocols, the device still has to be physically connected to the Internet. These problems must be solved at low cost and high reliability before Internet SCADA can be implemented in industrial applications.

The third is that many security and network issues must be tackled when using the public Internet for applications that are as business critical as a SCADA system.

PCs in the field?

One solution to these problems is to connect the device to a PC and have the PC make the connection to the Internet via an Internet Service Provider (ISP) using Secure Socket Layer (SSL). Unfortunately, this solution does not meet the low-cost criterion, and lacks the level of reliability that is demanded by oil and gas system operators. PCs, after all, are designed around the concept of regular human interaction – the PC user can be relied upon to reboot the machine if a crash occurs. The major benefit of Internet SCADA is that it allows the operator to interact with the device from a remote location; so even if the cost was acceptable, pressing a reset button never will be.

Smart field devices

The more appropriate alternative to using a PC is an embedded solution: a small, rugged, low-cost device that provides the connectivity capabilities of the PC, but at a lower cost and higher reliability. This device (sometimes referred to as an Internet Gateway) is connected to the equipment, generally via a serial port, communicates with the equipment in the equipment's native protocol, and converts the data to HTML or XML format. The Gateway has an IP address, and supports all or at least parts of the TCP/IP stack – typically at least HTTP, TCP/IP, UDP, and PPP.

The preferred data transmission protocol is HTTPS (or HTTP when security is not required), because it is firewall-friendly, and allows Web servers to be used to control data transmission. The alternatives, TCP/IP or UDP, require the cooperation of the customer's IT department to open ports on servers, and thereby introduce potential for cyber attack.

The introduction of the Gateway into the

SCADA system provides the opportunity to abandon the traditional POLL/RESPONSE architecture, and replace it with a PUSH architecture. In this architecture, the Gateway polls the field device in its native protocol, parses the returned data, and processes it for preconfigured exceptions, e.g. status change, analog value outside of a dead band, or an event such as time. Only these exception data are converted to XML and PUSHED (HTTPS POST) to Web servers for insertion into the real-time and historical databases.

Sharing internet connectivity

It is possible to Web-enable any piece of equipment today using either of the approaches described above. However, the physical connection to the Internet is still a problem. Many potential applications may not have the value to justify an individual IPP/ISP account, so it is often necessary to create a low-cost Gateway network in order to share the IPP/ISP subscription cost among several pieces of equipment. The Gateway, with its embedded proxy server, controls these wired and wireless networks, supporting dynamic IP addressing (Dynamic Host Config-uration Protocol or DHCP), and providing non-routable IP addressing to the connected equipment.

Internet SCADA surety

Special precautions must be taken to ensure that Internet SCADA systems are safe from being compromised by outside users and systems. The concept of SCADA "surety" includes security, availability, integrity, confidentiality, and access controls. These concepts are defined below:

- Security – The open nature of the Internet requires careful consideration of data security measures when implementing Internet SCADA systems. Processes, procedures, and tools must be put in place to address availability, integrity, confidentiality, and protection against unauthorized users.
- Availability – System up time must be maintained at the highest levels through use of redundant servers. Firewall protection must be provided in the Gateway and servers, along with automated detection and mitigation of cyber attacks such as denial of service attacks.
- Integrity – System must ensure that data is not modified or corrupted through use of encrypted data signatures and authentication to restrict access.
- Confidentiality – System must ensure restricted access to data through use of encryption, and to the system by employing authentication such as Secure Socket Layer.
- Protection against unauthorized users – Multi-layered password protection must be provided at all levels in the system.

Other issues

In addition to the above, the considerations below must be taken into account.

Integration and interoperability. The open architecture of an Internet-based SCADA system, combined with appropriate field equipment, makes it possible to develop an integrated SCADA system. However, interoperability requires data format and transmission protocol standardization.

The preferred data format is Extensible Markup Language (XML). XML was developed to bring greater flexibility and interoperability to Web applications. It is a meta-language for describing markup languages and therefore does not specify semantics or a tag set. In other words, XML provides a facility to define tags and structure. XML provides flexibility not available from HTML, because the programmer has the freedom to create tag sets and semantics. The simpler alternative markup language, HTML, has undergone continuous development to support new tags and style sheets. However, these changes are limited by the requirement to be backwards-compatible, and to what the browser vendors are willing to support.

Scalability. Scaling an Internet SCADA system from a few to thousands of assets, while maintaining near real-time performance, requires a system architecture that enables data to be pushed from the remote equipment without host system polls. This approach has been implemented in systems supporting simultaneous 20-second updates from 3,000 devices.

Data presentation. As the acronym implies, the purpose of a SCADA system is to allow asset owners and operators to monitor and control remote assets. Therefore, the presentation of data is a critical component of any Internet SCADA system. The use of Internet protocols and services to collect data makes it simple to use standard Web browsers for data presentation.

The technology chosen for development of the Web page user interface (UI) must support development of sites that are highly dynamic, incorporate animation, and provide a high level of usability. Standard Web page technologies such as HTML, JavaScript, and Macro-media FLASH are ideal for the development of SCADA presentation pages.

Implementation options

Implementation of an Internet SCADA system is a complex project that may be handled in one of three different ways:

- Owner may purchase components, and either act as integrator or hire one
- Contract for a turnkey SCADA installation
- Contract for turnkey subscription-based SCADA services.

Experience indicates that complex SCADA projects are generally best handled by a single vendor acting as system architect with responsibility for the total solution. On the other hand, a credible alternative to this traditional approach is to simply contract for SCADA services on a subscription basis. For a monthly fee, some vendors design the system, install field hardware if necessary, operate secure servers to host the data, and provide customers access to their data via a standard Web browser.

An example

Delivering natural gas from well to burner tip is an enormous enterprise. The majority of the natural gas consumed in the United States is produced at remote sites. It must then be transported to consumers through more than 250,000 miles of transmission pipelines, with the help of thousands of compressors.

The Hanover Compressor Company is the leading provider of natural gas compression services, maintaining a 3.7-million-horsepower rental compression fleet that is the largest in the industry. In southwestern U.S., near Farmington, New Mexico, Hanover operates over 300 high-value compressors.

As part of ongoing improvements to increase this value, Hanover required an economical way to remotely access compressors, and electronically monitor and control operations over a wide range of communications media.

The project

Hanover selected an Internet-based SCADA system that continuously monitors PLC-based compressor control panels. From the Internet, operators view key operating parameters such as status, suction pressure, discharge pressure and error codes, and start and stop units without having to travel to the site.

Onsite, rugged Gateways manage the link between the compressor control panels and the Internet SCADA data center. The Gateways communicate with the panel in its native Allen-Bradley DF1 protocol and data format, and convert the acquired data to XML format for transmission on an exception basis to the data center.

The turnkey Internet SCADA system includes complete SCADA functionality, application hosting and management, satellite communications, and all field hardware and services. The system provides Hanover with:

- Fast, low-risk implementation through a packaged system that is engineered, integrated, and tested before the field hardware is shipped.
- Flexible I/O that supports a broad range of sensors, PLCs, and compressor control panels.
- Secure Web browser access from anywhere in the world, for viewing real-time and historical operations, alarm data and reports, and performing remote compressor starts and stops.
- Immediate alerts to operators and field engineers on critical operations, so they can get a technician out to the field quickly. Alarm notification over phone, cell phone, pager or Internet, 24-hours a day, ensures complete coverage for remote or unattended operations.
- SCADA application is modular, so subsets of the functionality can be provided for lower-value compressors in the future at a lower cost,

Internet-based SCADA systems enable operators to access real-time and historical data, such as exhaust temperature trends, from anywhere in the world.

while data is accessed from and aggregated within the same overall system.

Hanover's results

Using an Internet-based SCADA system allows Hanover to maintain highly reliable service, and increase customer production revenues resulting from higher "on stream" performance. Other operational advantages include:

- Provides an alert when a gas compressor stops operating, allowing field maintenance personnel the opportunity to quickly go to the inoperative unit and get it back up.
- Enables operators to analyze historical performance and trends to better predict imminent problems and to better diagnose current problems.
- Eliminates false or nuisance alarms caused by extreme site conditions and communications failures.
- Provides its users with the ability to better schedule field personnel by empowering them with the ability to know the status of their production equipment any time, from anywhere.
- Rapid deployment minimizes field resources and means more compressors can be automated more quickly.
- Single-source, fully integrated system means less hardware to buy, less fieldwork, and simple coordination of a cost effective, reliable system.

Return on investment

Hanover found that the Internet SCADA system cut response times from two or three days to hours, which resulted in higher service revenues to compressor operators ($3,000 on average per incident), and happier customers ($25,000 average increase in production revenues).

Conclusion

Internet-based, secure, real-time SCADA systems are now a reality, and offer many benefits:

- Provide a corporate-wide solution that integrates new and legacy field automation, SCADA, and related equipment.
- Allow companies to flexibly choose equipment and systems based on price/performance rather than compatibility with installed base.
- Scale quickly from a few sites to thousands.
- Result in a single solution suitable for both local and enterprise-wide oil and gas applications.
- Can be quickly implemented through subscription service contract options. This reduces SCADA project risk, because companies pay only upon commencement of service, and no capital investment is required. ✣

Acknowledgment

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The author

Donald I. Wallace is president and CEO, M2M Data Corporation, Denver, Colorado.