Smart Fields Come Of Age With Internet-based SCADA

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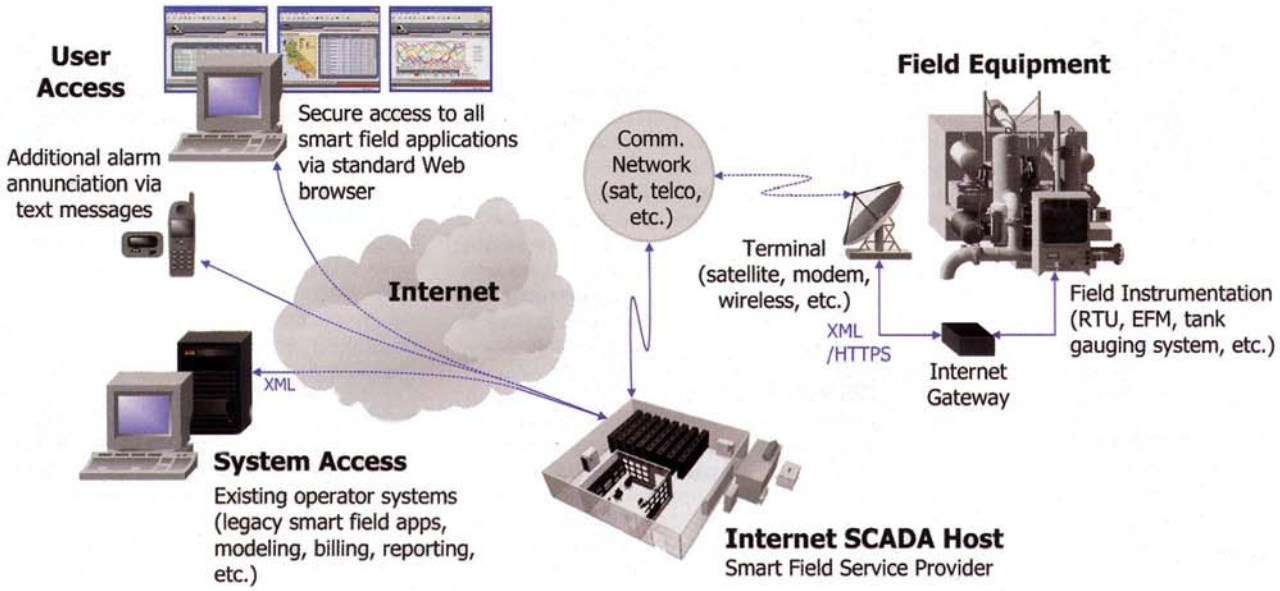


Use of Internet SCADA as the basis for a cost-effective enterprise smart field system has finally moved from promise to reality. The demand for affordable monitoring and control of remote oil and gas assets is exploding, and many companies are now considering using the Internet and supervisory control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

Often referred to as man-to-machine, machine-to-machine, or mobile-to-machine networks, smart field systems enable oil and gas companies to monitor, manage and operate equipment more reliably and more efficiently with fewer trips into 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 also eliminates the cost and complexity of long distance communications because each piece of remote equipment is connected to a local Internet Service Provider (ISP). However, actually achieving these benefits through the implementation of an Internet SCADA smart field is fraught with problems that require the attention of experts in the field.

Implementation Challenges

There are three significant challenges to overcome when implementing an Internet SCADA smart field.

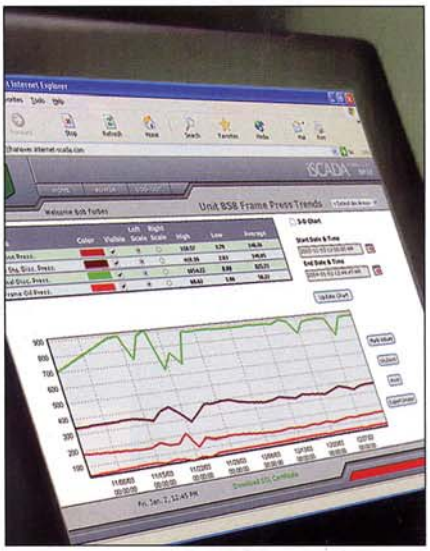
The first is that most devices used to control remote equipment and processes such as gas production wells do not have Internet communications capability already incorporated in their operating systems. In fact, many do not even have an electronic controller, let alone an operating system.

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 smart field.

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 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.



Embedded Solution

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 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. Once connected to the Internet, the Gateway responds to an HTTP request with an HTML or XML file, just as if it were any PC server on the World Wide Web.

In cases where the equipment incorporates an electronic controller, it may be possible to simply add the Web-enabled functionality into the existing micro-controller.

Sharing Connectivity

It is possible to Web-enable any piece of equipment today using either of the approaches described here; however, the physical connection to the Internet is still a problem. Many potential applications may not have the value to justify an individual ISP account, so it is often necessary to create a low-cost Gateway network in order to share the 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 Configuration Protocol or DHCP) and providing non-routable IP addressing to the connected equipment.

Smart Field Surety

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

Security: The open nature of the Internet requires careful consideration of data security measures when implementing Internet SCADA smart fields. 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 monitoring to detect DNS attacks.

Integrity: System must ensure 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

Integration and interoperability are other significant issues. The open architecture of an Internet-based SCADA system combined with appropriate field equipment makes it possible to develop an integrated smart field 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.

The preferred data transmission protocol is HTTP (or HTTPS when security is 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.

Scalability

Scaling an Internet SCADA smart field 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 SCADA-based smart field. 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 Macromedia FLASH are ideal for the development of SCADA presentation pages.

Implementation Options

Implementation of an Internet SCADA smart field 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; or
- Contract for turnkey subscription-based smart field 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.

An important alternative to this traditional approach is to simply contract for smart field 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.

Example

The use of Internet-based SCADA smart field to monitor and control gas production wells has been proven to improve production and lower maintenance costs. For example, a field operator installed proprietary gas flow computers at nine wells to record flow data and store it for collection once every 20 minutes via an Internet SCADA smart field subscription service.

The operator estimated that operational efficiencies achieved through use of the service resulted in production increases of 7% per year. The subscription service fee was $25 per month per well for a period of 36 months and the cost of field automation equipment was $30,000. Using a discount rate of 10% and $1.50 per Mcf gas price, the project return on investment was calculated to be in excess of 500%.

Conclusion

Internet-based, secure, real-time SCADA smart fields 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, and;

Can be quickly implemented through subscription service contract options. This reduces smart field project risk because companies pay only upon commencement of service, and no capital investment is required. ***P&GJ***

Author: Donald Wallace *is a graduate of the University of East London. He is a professional member of the British Computer Society (www.bcs.org), and a past director of the HART Foundation (www.hartcomm.org), an industry group formed to standardize sensor data communications. He holds two patents for wide area telemetry (SCADA) and has more than 30 years of experience in the design, marketing, and sale of complex systems for industrial automation and data communications applications.*