AN UPDATED EXAMINATION OF WEB-BASED SOLUTIONS FOR ORIFICE MEASUREMENT & MONITORING — 2014

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Introduction

In today's Internet-centric age of instantly accessible information, the development of practical and cost-effective web-based solutions in energy measurement is a logical extension of the latest technologies. Major pipeline companies have long been dependent on advanced measurement and communication technologies, such as Supervisory Control and Data Acquisition (SCADA). But with advanced electronic flow measurement and communications technologies, ever-increasing bandwidth, ubiquitous Internet access, high energy prices, and chronic personnel shortages, remote monitoring services have become a profitable solution for every segment of the industry…including small and mid-size companies. This whitepaper will provide the basic blueprint of a system for leading-edge, web-based measurement and monitoring solutions, along with a review some of the benefits and challenges facing this transition to a more digital environment, and will summarize two representative case histories.

Measurement

Field Equipment – Selecting a flow computer system (including primary, secondary, and tertiary devices) for orifice measurement is generally not an overly difficult task. Most flow computers support communications, but are often located in remote areas without electrical power or telecommunication landlines. When identifying equipment needs, the key factors are location, power, and automation requirements. Accordingly, it's a good idea to conduct an initial study to determine how best to accommodate these requirements. Outlined in Table 1 are typical specifications for a solar-powered, battery-operated flow computer which may be routinely polled up to hourly, supports orifice measurement of gas, stores turbine meter and well pressure data, accommodates alarms, and monitors tanks levels.

Typical Flow Computer Specifications for Remote Service

Flow Computer which performs current AGA 3 calculations and stores AGA data according to API Chapter 21 specifications, including:

- 40 Watt Solar Panel
- 105 Amp-Hour Battery
- Additional Digital I/O
- Additional Analog I/O
- Additional Discrete I/O
- Additional Pulse I/O
- Cellular Modem
- Antenna / Cable Assembly / Polyphaser
- 5-Valve SS Manifold
- Miscellaneous Mounting/Installation Materials

Table 1

Communications – Today there are multiple wireless technologies available for communicating with electronic flow computers, such as cellular, spread spectrum radio, and satellite. The communications infrastructure will often incorporate a combination of these technologies, along with a landline connection. Cellular communications employ various standards depending upon the carrier, location, and features offered. For example, CDMA (Code Division Multiple Access), upon which some 3G (third-generation) wireless technologies are built, has become one of the most dependable and cost-effective IP addressable communication services available for M2M (machine-to-machine) systems. CDMA is a "spread spectrum" technology, allowing many users to occupy the same time and frequency allocations within a given band of frequencies and physical channel. Another popular standard is GSM (Global System for Mobile Communications), widely used worldwide for both 2G and 3G networks. LTE (Long Term Evolution) is among the newest mobile communications standards and provides the foundation for many carriers' advanced high-speed 4G networks.

Data Collection – The data collection system should preferably interface with all major brands of flow computers on the market and typically in use. This allows consolidated data collection, minimized technical support requirements, and the flexibility to change meter brands, as necessary. It is imperative, however, that the collection system is designed to retrieve data in an API Chapter 21 compliant format so that measurement data is available for validating, editing, and archiving according to established industry standards. This is a critical feature when selecting a system or service since the failure to produce an acceptable audit trail may have serious legal ramifications in the event of a payment dispute for gas sales or revenue distributions.

Data Storage & Retrieval – Data storage and retrieval is as critical as the data collection process itself. You should first determine the amount of data you expect to collect, then choose a sufficiently robust and fully functional database capable of handling this quantity plus archival and future growth volumes. As data is collected it will be written to this database and is then available for retrieval when users access the web pages for current or historical information. Information may also be "pushed" directly to end-user workstations, tablet computers, and smartphones. Figure 1 is a high-level depiction of the major components for a comprehensive data retrieval, processing, storage, delivery, and archiving system…including advanced wireless communications.

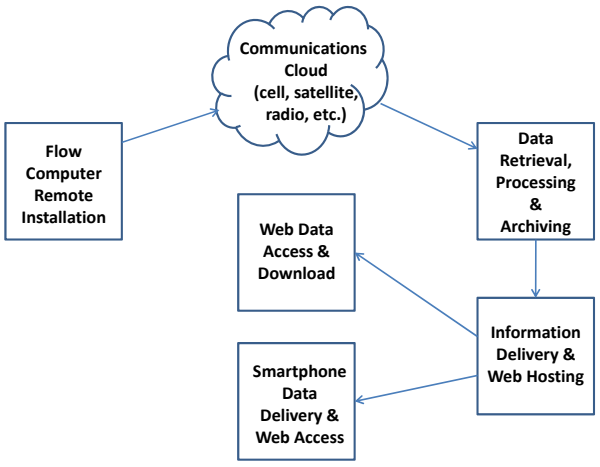

Figure 1

Flow Data Validation – Meter data should be imported into a measurement software system so that the information may be auto-validated and auto-edited before it's made available for web-based review and optional download. This process is usually completed within seconds, with as many as 300 validations performed on each hourly record. At a minimum, this should include automatically detecting missing data and flow anomalies, updating analytical values, and providing volume corrections wherever necessary. This will eliminate most delays in preparing measurement data for invoicing while providing users with near audit quality data every day. While we're not suggesting that this process will fully validate measurement data for custody transfer each day, it will yield much more reliable daily information for budgeting, forecasting, maintenance, operations, and nominations.

In order to fully validate gas measurement data, it is necessary to review a complete flow data trend for the month, along with all effective meter inspection and calibration reports and gas analyses. Since that information is often unavailable until the end of the month, a final verification cannot be completed until all of those records have been reviewed and revisions applied, where necessary.

Monitoring

Web Access – Web-based access to flow and well data should be protected and restricted to only authorized users through appropriate authentication provisions. Another important system feature is a user interface that allows field personnel to enter flow or well data from charts or other sources that cannot be automatically polled, such as tank levels, well pressures, temperatures, etc. This information can then be updated, along with similar data from electronic sources, to provide producers or gatherers (and their partners) with web-based access to an entire system, regardless of whether the production and/or measurement process is manual, automated, or a combination of both.

Reports & Graphs – Basic system reports should include a summary, current flow, daily volume, hourly volume, station alarm, decline curve, previous month's activity, and well data. These reports should be available in both tabular and graphical forms, with options to view and save or download in standard spreadsheet formats. In addition, a system summary report should automatically be emailed each morning to provide the user with the previous day's information including a system balance and alarm report. This will enable personnel

to schedule and conduct maintenance only where it is required and make more efficient use of their time. The system should also automatically generate a report when the gas "Un-Accounted For" (UAF) exceeds acceptable tolerances.

Demand Polling – Polling systems are sometimes scheduled to routinely retrieve flow and well data only several times per day, especially as a means to conserve power. A demand poll function provides the user with an ad hoc means to activate data collection and retrieve up-to-date information whenever necessary, such as for production optimization and troubleshooting initiatives.

Alarms – This is a key feature to ensure that operational personnel are immediately notified whenever out-of-range or upset conditions occur, thereby providing the opportunity to troubleshoot and resolve problems without undue delays. Alarm messages and alerts should be delivered via email, pager, cell phone, text message, etc., and should be routed through a contact tree until notification is received and fully acknowledged. This is extremely beneficial in minimizing downtime, maximizing production, and responding to emergency situations. A combination of alarm communications methods may also be employed so that mission-critical alerts (such as for "no flow" conditions) are always sent by the fastest and most reliable means.

Miscellaneous

System Security & Protection – Security measures and other methods of protecting data are often overlooked until after a breach or failure occurs. Implementing even simple steps will help ensure that your critical data will be intact and readily available. For example, an uninterruptible power supply (UPS) is an inexpensive yet critical piece of hardware that should be used to physically protect all servers to avoid data loss or equipment damage due to power surges or failures. Additionally, we strongly recommend installing an Internet-facing firewall to protect your network, along with intrusion detection/protection provisions. Firewalls often come preconfigured and, with minimal additional custom configuration, ready to run. Encryption is another powerful yet relatively easy to deploy security measure for protecting proprietary information and sensitive data, "at rest" or "in transit." Strict security should always be an integral component of your overall system design and operation, with routine tests and audits to ensure proper, effective performance.

Benefits – Web-based measurement services can furnish up-to-date flow and well data, identify upset conditions, provide alarms for exception conditions, collect information to allow revenue projections, expedite critical business decisions, and, ultimately, increase revenues and profits. Used in conjunction with prudent measurement policies and procedures, they can also verify gas sales, expedite gas accounting and reservoir analyses, and furnish third-parties with on-demand, Internet-based access to flow and well data. And through the implementation of advanced remote data retrieval and alarm systems, information may be broadly disseminated in real-time or near real-time fashion while mission-critical operational alerts can be instantaneously communicated.

Case Histories

Case History 1:
Shell Oil — Electronic Field Capture

Summary

Shell Pipeline Company's offshore Louisiana operations needed to quickly, efficiently, and accurately collect and submit platform data from production measurement equipment without using facsimile transmissions or hardcopy means to send the data to onshore facilities for processing. Shell strongly preferred a method through which information could be gathered and viewed in a similar manner as data which is automatically retrieved from flow computers and other electronic devices. Using Electronic Field Capture, a web-based SaaS (Software-as-a-Service) application developed by BirdDog™ Information Systems (a division of Coastal Flow Measurement, Inc., Houston, TX), Shell fully achieved their objectives without the significantly higher costs of deploying and maintaining a SCADA system. The result was a more dependable, accurate, and timely process for collecting platform production data, with savings in staff time and expenses compared to the former manual processes.

Background

In 2007, Shell initially approached Coastal Flow Measurement for help in automating their daily offshore measurement data collection and communication. At the time, this Shell unit was operating pipelines connected to approximately 200 offshore

platforms in the Gulf of Mexico. Daily reports were being submitted via facsimile transmission and in hardcopy form from their offshore platforms, but late, erroneous, and incomplete submissions were a difficulty for production management. And once the data was received, the field office would then have to file and maintain the hardcopies for future reference. The entire process was time consuming, inefficient, and expensive, with a decidedly negative financial impact on the operating budget.

Goals

Shell's original objectives in pursuing an electronic system for information retrieval included:

- Eliminate the manual, inefficient process of report submittal via facsimile transmission and other hardcopy procedures;
- Implement an infrastructure, system, and process to ensure the timely transmission of accurate data, with greater accountability for platform personnel; and
- Leverage the Internet to provide for easy web-based access to data stores with routine electronic archiving.

Solution

Coastal Flow already had a demonstrated proficiency in electronically capturing operational data (that cannot be automatically retrieved) with its data collection service through which field technicians connect to measurement equipment and download data to their computers. This process is accompanied by a completely manual procedure for collecting data that is not available for electronic capture, but which needs to be recorded, processed, and stored. *Coastal Flow's* BirdDog Information Systems division also offered a commercial Remote Data Retrieval (RDR) service which is widely used throughout the oil and gas industry. With RDR, captured data is "webized" for easy access with only a browser and Internet connection.

Following development of a requirements document, the next step was to identify the measurement equipment and specific data fields for which collection was needed, so that a functional specification could be completed and approved by Shell. A web-based application to easily permit the platform data to be entered into a central repository for processing and retention was subsequently developed, comprehensively tested, and hosted by BirdDog Information Systems. A fully commercial version of this SaaS system was later released by BirdDog and is called Electronic Field Capture.

The Electronic Field Capture system employed by Shell on its platforms allowed operational data to be collected for subsequent access, viewing, and archiving in a similar fashion as for data that is automatically retrieved from flow computers and other electronic devices. By having the platforms enter their data through the web-based Electronic Field Capture system, the need for submission by facsimile transmission or hardcopy communications was largely no longer needed. Once entered, the data is validated and automatically distributed by the system, which also ensures on-time reporting. All data is electronically archived through BirdDog for ready access by authorized Shell employees and entitled third-parties via web browser.

Results

Through deployment of the Electronic Field Capture system, Shell was able to virtually eliminate the use of facsimile transmissions and significantly reduce the manual distribution of measurement-related platform operational data, with the added benefit of improved on-time reporting and greater overall data accuracy. Once submitted, all data is consolidated into the master database for 24x7 web access across the Internet. More timely and easy access to the data permits faster identification of upset conditions for quick response and remediation. The database is also archived and can serve as a supplemental DR/BC (Disaster Recovery & Business Continuity) resource for Shell.

Features of the BirdDog Electronic Field Capture system used by Shell include:

- Application of validation checks immediately upon data submission;
- Prompt distribution of reports following data submission and validation;
- Timely communication of system alerts for missing, suspect, or out-of-range data;
- Optional creation of system balance configurations and reports;
- Automatic preparation of monthly reports and data file exports;
- Secure 24x7 Internet-based access and viewing of data, including graphically, by authorized company and entitled third-parties; and
- Archive of all submitted data in a central repository for access to historical information and DR/BC use.

Conclusions

A properly designed, built, and deployed SaaS system for the submission of disparate data from oil and gas industry production operations can provide a significant ROI. Both hard-dollar and soft-dollar benefits are available through more accurate and timely data collection; validation checks for missing or suspect data; operational alerts for upset or out-of-range conditions; reduced staff time and expenses for manual processes; and improved regulatory compliance through more timely and complete reporting. The Electronic Field Capture System developed by BirdDog Information Systems for Shell's offshore Louisiana platform operations has provided the comprehensive solution and economic benefits originally targeted by this project.

Case History 2:
Penn Virginia Corporation — Remote Alarming of a Salt Water Disposal System

Summary

Penn Virginia Corporation (PVA) sought a notification system to help ensure compliance with environmental and regulatory requirements for waste salt water disposal (SWD) in their East Texas oil and gas fields. PVA strongly preferred a method through which information could be automatically gathered, viewed, and processed in a similar manner as production data retrieved from flow computers and other electronic devices. Through a customized version of Remote Data Retrieval, a web-based SaaS application developed by BirdDog Information Systems, PVA accomplished their objectives without incurring the significantly higher costs of deploying and maintaining a full SCADA system. The result was an integrated, accurate, and timely process for collecting SWD system data and then performing system balances around the source and disposal points as a first-alert for potential leakage conditions. This system provided financial savings through a more cost-effective solution than SCADA to minimize the potential for incurring system leaks with their correspondingly expensive clean-ups and possible fines.

Background

The expansion of oil and gas production operations in PVA's large East Texas Scottsville field with more than 300 natural gas wells has been accompanied by increased quantities of salt water that must be handled and disposed of properly. The field operators needed a proactive way to quickly determine when salt water leaks might be occurring, an especially challenging situation given the large number and diverse locations of salt water production, transfer, and disposal points in the field. Ideally, a monitoring system would provide timely first-alerts on conditions indicative of potential leaks in the SWD system before an environmental impact were experienced. In addition to the environmental issues which could result from system leaks, PVA recognized that large fines could potentially be levied by various regulatory agencies and a reputational penalty might result if waste brines were not properly handled.

PVA had already been extensively utilizing the BirdDog Remote Data Retrieval system…to routinely electronically capture well production data from flow computers and webize it, for shared user access, to review operating conditions, for out-of-range alerts, and for historical data archiving. Based on their positive RDR experiences and existing infrastructure, PVA management approached the BirdDog Information Systems development team to explore options for leveraging their existing RDR system for meeting their SWD monitoring and alarming requirements.

Goals

PVA's original objectives in pursuing automated electronic alerts for its SWD system included the following:

- Significantly minimize the potential for adverse environmental impact events and regulatory violations through near real-time system balancing and alerts for out-of-range conditions;
- Provide operations personnel with an easy to use, readily accessible, and highly scalable system for viewing current as well as historical data;
- As feasible, utilize existing systems to accelerate development and deployment timelines while reducing end-user training requirements; and
- Control upfront expenses and total cost of ownership within budgetary allocations

Solution

The BirdDog Remote Data Retrieval (RDR) system was originally deployed with PVA to electronically capture operational data from well flow computers

through a combination of radio and cellular communications. The RDR system had quickly become integral to PVA's operations, allowing both field and office personnel to view current and archived well system data via the web with only a browser and Internet connection. To achieve the SWD system objectives, a detailed plan was jointly prepared for development, testing, deployment, and post-launch monitoring.

Among the primary steps and considerations were the following:

- PVA provided a detailed schema of SWD system inflows, outflows, and monitoring points, with target balancing objectives based on empirical data, for development of the new BirdDog RDR system functionality;
- Turbine meters at the monitoring sites were wired into the nearest flow computers, for communications purposes, to collect hourly volumes; these meters had to be retro-fitted with new output boards;
- BirdDog Information Systems developers had to configure the existing RDR at PVA to automatically poll and collect the additional SWD system data coming from the monitoring points;
- Using the captured SWD system data, RDR was programmed to perform an automated hourly balance; and
- Should any hourly SWD system monitoring show out-of-balance conditions which exceed preset limits, PVA operating personnel would be alerted via text and email so that further investigations could be conducted and, if necessary, corrective action taken.

As noted, one of the unexpected requirements encountered during the development, testing, and operational implementation of the customized RDR system was the discovery that the turbine meters had to be retro-fitted with new output boards. This resulted in slightly higher upfront costs, but was still well within the project's contingency budget.

Results

Once fully deployed into the production environment, the customized BirdDog RDR system with alarming allowed PVA to closely monitor and quickly react to conditions indicative of potential SWD system leaks, with balancing updates performed hourly. Along with routine collection and presentation of production data, including a daily morning report pushed by the system to key PVA personnel via computer, tablet, and smartphone, monitoring the SWD system in this manner has provided an important tool for helping PVA to ensure regulatory compliance.

Conclusions

By leveraging SaaS-based systems and advanced communications, a cost-effective and rapidly deployed first-alert capability was feasible to significantly minimize the potential for an expensive environmental event and regulatory violation. A customized enhancement to the BirdDog Remote Data Retrieval system provided monitoring and alarming functionality that allows production personnel to quickly recognize and respond to potentially disastrous conditions.

Final Comments

There is a natural tendency to overestimate the integrity and accuracy of raw gas measurement data, especially when computer generated and automatically posted to a website. The evidence is clear since many companies currently rely on raw flow data collected directly from the field for sales allocations and regulatory reporting purposes. While we recognize that measurement practices for field allocations do not necessarily have to be as stringent as custody transfer measurement guidelines, flow data should be validated and edited by a certified measurement analyst each month in order to furnish the accurate information that is necessary for accounting, regulatory reporting, and revenue distribution. Web-based access to flow and well data is a relatively simple process that can provide users with a wealth of information…and robust remote data retrieval systems can now significantly increase the "immediacy" of data collection, processing, delivery, and archiving. Such data collection systems and infrastructure may also be further leveraged to meet a variety of ancillary operational objectives, as exemplified by the presented case histories. Obtaining "accountable" measurement data is an extremely worthwhile, cost-effective objective that is available through highly specialized resources and should be the ultimate goal whenever designing a system, establishing service requirements, or setting service level agreements (SLAs) with business partners.