METHODS OF GATHERING EGM DATA

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Modern methods for collecting Electronic Gas Measurement (EGM) data are driven by existing and emerging demands throughout the industry for more accurate and timely collection, reconciliation, accounting and sharing of gas measurement data as well as regulatory demands for increased operational safety and control of oil and natural gas production, collection and distribution. Increased bandwidth requirements are forcing companies to explore new communications technologies and field equipment to provide solutions to these demands. At the same time companies are trying to improve the management efficiency of their presently installed equipment and communications infrastructure.

Changing Business and Regulatory Demands

Accurate measurement and accounting of gas and liquid volume data has always been a critical business requirement in the oil and gas industry. Initially these requirements were satisfied with local chart recorders at each measurement point. These recorders typically recorded basic parameters such as delta pressure, static pressure and temperature. Collected charts were then processed to determine corrected volumes for custody transfer accounting. With the advent of microprocessor based flow computers, many of the required AGA or API calculations are performed by the flow computer on a continuous basis. Initially daily and later hourly averages of pressures, volumes and temperatures were archived by the flow computer for periodic retrieval by data acquisition (SCADA) systems. Since most flow computers were capable of storing at least a month of such data, data acquisition was not really time critical or high performance. Similarly, the communications requirements were low bandwidth and 1200 BPS Dialup Modems or radios were sufficient.

Total data and accounting requirements escalated rapidly when new regulations demanded that natural gas be sold according to actual energy content rather than volumes. This requirement imposed added complexity to the calculations required of flow computers and accounting departments. Required AGA calculations now required gas quality data to more accurately determine corrected volumes and energy content. Initially, gas quality was determined by laboratory analysis. This was no problem if products handled at a measurement point remained constant for long periods. In this case, gas quality data used for calculations could be updated periodically at the flow computer or raw data could be recalculated using available editing software. This problem became much more severe for meters exposed to frequent changes in product mix. Today, modern field proven gas analysis devices such as gas chromatographs are frequently deployed either locally connected to Flow Computers or upstream of metering points. Data from this equipment must now be acquired by the SCADA system and possibly redistributed to affected flow computers. In short, the total amount of raw and calculated EGM data to be collected and reported by the data acquisition and accounting systems has grown dramatically.

In addition to actual EGM data, business and regulatory demands have also imposed a much larger burden on field equipment, SCADA systems and communications resources for real-time data and command capabilities. Modern gas operations require close supervision of field equipment for both safety and operating efficiency. In addition, dedicated systems for leak detection, reservoir management and other engineering functions all require access to field data. These demands represent both an increase in total data and in the frequency by which the data must be read or written. In most systems, real-time data for valve control and remote supervision of field equipment are either handled by the same equipment used for flow calculations and archival or by dedicated equipment that must use the same communications resources. In either case, older SCADA systems and communications networks, initially designed to read basic flow data once per day are now required to interlace higher performance real-time data polling and demand transactions with more frequent EGM archive retrieval. These combined requirements may require updated field equipment and frequently exceed the capacity of older communications networks.

Emerging trends in business-to-business (BTB) relationships and the demands of energy trading activities also demand more rapid collection, reconciliation and distribution of Flow Measurement

data. Flow measurement data in some applications is now treated the same as real-time data. In some applications, flow data from field flow computers, once gathered hourly or daily is now uploaded every fifteen minutes.

Enterprise Gas Measurement Systems

For all of the reasons stated above, companies must now address all aspects of their real-time and EGM gathering systems as an integrated system to insure that both present and future requirements of operations, maintenance, accounting and business relationships can be managed efficiently. In an ideal world, companies could simply install new optimized systems that perfectly suited all their requirements. They could carefully select field equipment such as flow computers, gas analyzers, valve controllers that performed all of the required functions. They could select communications networks that perfectly suited their requirements in both bandwidth and cost. They would purchase data acquisition systems that perfectly matched their selected equipment and communications resources, possibly supplied with the equipment. Finally, they would purchase operator interfaces, gas measurement systems, accounting systems and Internet capable business systems that all interfaced seamlessly. In the past they might purchase the entire system from a single supplier to insure a complete working system. Otherwise they might simply purchase the best of each type of component and rely on the supplier's support for recognized industry open architecture standards and data interchange formats to insure seamless integration. Of course, in the real world, no company can afford such an approach. Aside from being cost prohibitive, almost all companies have existing systems that include a multitude of either purchased or internally developed solutions that have evolved over the years. Modern merger and acquisition activity insures that no company has a single type of flow computer or other type of device. Most companies have inherited legacy equipment installed by others using communications resources spanning the entire history of EGM collection. Even within companies, field equipment has changed over the years because of changes in prevailing technology and business requirements at the time of purchase. As newer equipment and communications methods are deployed, companies must still maintain their existing EGM infrastructure and must continue to collect gas measurement data from these systems. In most companies incremental improvements occur simultaneously at various levels within the overall enterprise system. Figure 1 shows a simplified block diagram of the components found within a modern enterprise gas measurement and reporting system. Although some components are not involved in the process of gathering EGM data,

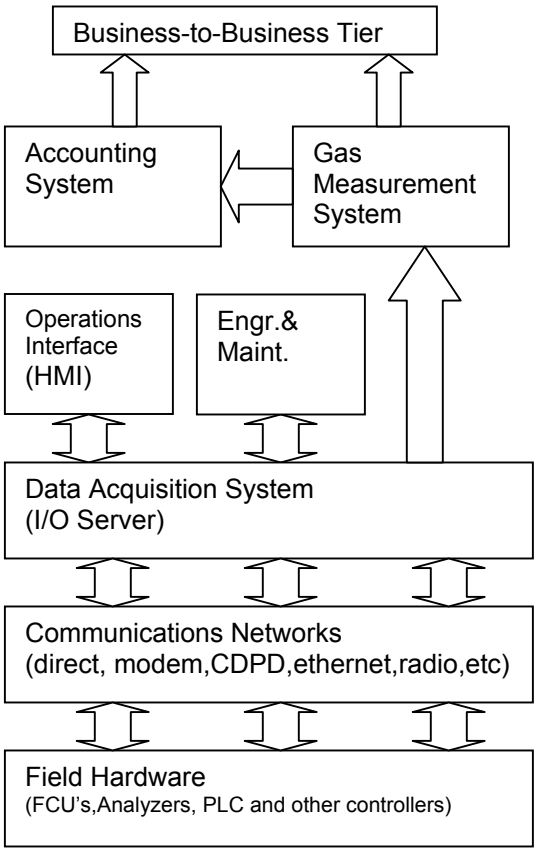

Figure One – System Architecture

all are shown to illustrate how collected data is processed throughout the enterprise system. This is an important consideration in designing the data acquisition system since simple collection of data from field devices would be pointless unless the data can be presented to the other components of the system in an acceptable format. The requirements and functions of the components are as follows:

Business-to-Business Tier – this top layer provides the features required to share Gas Measurement and accounting data with business partners or customers. This aspect of the industry has appeared with the advent of the Internet. Depending on the nature of the company business, exchanged data may represent both real-time and gas measurement data for shared pipeline operations, data collected by a gathering company on behalf of the owner of the resources or data shared between producers and their customers.

Accounting System – this layer of the hierarchy is the traditional accounting function responsible for reporting and billing operations.

Gas Measurement System – the functions performed by the gas measurement system include reconciliation and verification of gathered field data

as well as editing of raw field data to correct actual volumes and energy values reported to accounting. Editing of raw data is required if there is a justifiable reason that the raw data is in error. Reasons may include such events as a change in orifice plate sizes or gas quality information that was not downloaded or entered into the field flow computer. In these cases, the raw field data for delta pressure, static pressure and temperature are used to recalculate the total volumes and energy content using the same AGA calculations used by the field flow computer. In most operations, such recalculations of field data are always performed by the gas measurement system on a routine basis. The results are then compared to the calculated data from the field device to check for discrepancies. An important role of these systems is to maintain a complete audit trail of all changes and their associated reasons to all data gathered from the field and reported to accounting.

Operations Interface

Aside from EGM data collection, operators require a real-time interface to data collected from field devices. Most operations must supervise and control pipelines, compressor stations and other gas production and transportation equipment continuously. Data is usually presented graphically with provisions for operators to issue commands to field equipment for valve control or to perform other operations locally controlled by dedicated field equipment. Most operator interfaces allow provide control functions to allow operators to monitor and control EGM collection as well.

Engineering and Maintenance

Engineering and Maintenance personnel must have access to diagnostic and alarm data to quickly isolate and correct problems associated with field equipment or the communications network. Engineering personnel and subsystems must also have access to field data to perform reservoir management testing such as pressure build up tests, automated leak detection and required regulatory procedures.

Data Acquisition Subsystem

Central to the process of gathering both real-time and EGM archive data, the design of the data acquisition subsystem is critical to efficient flow of information from the field to the above systems that use the data. Its primary purpose is to manage polling for field data and present this data to the proper subsystems that require it. In addition it must insure timely transmittal of command data to the field equipment. Detailed discussion of the design elements and required features of data acquisition (SCADA) systems is included in subsequent sections.

Communications Network

While technically part of the data acquisition subsystem, the communications network is really designed or procured as a separate subsystem. As noted in previous sections, communications resources used for EGM data run the full spectrum of both old and new technologies. Due to the isolated and remote nature of most measurement points (meters), communications technologies chosen most often depend on cost, availability in the geographical area and performance requirements. Detailed discussion of the merits and pitfalls of each of these technologies is beyond the scope of this discussion. However, it must be noted that most medium to large operations use a variety of communications media including both internally maintained and commercially leased. Present systems use any of the following technologies:

Direct Copper Connections
Locally or networked radios of various frequencies
Standard telephone modems
Local and network wireless modems (CDPD)
Satellites
Network Protocols (TCP/IP and UDP/IP)

Newer, wider bandwidth methods for both radio and wireless communications are in the near future. In addition, a single communications path from the I/O server to a field device may involve multiple paths using different media to span larger distances. New systems also include hardware methods to consolidate data or share limited communications channels. In any case, most companies have invested heavily in either in-house systems or purchased bandwidth on public systems. For this reason, communications represents a major part of the initial cost and operating expense for EGM data collection.

Field Hardware

Ultimately, all data collected for either real-time or EGM must first be acquired by a field device. The earliest Remote Terminal Units (RTU's) or flow computers simply interfaced to local instrumentation to scan the main parameters used for measuring flow. This generally consisted of static pressure, temperature and either delta pressure for orifice meters or turbine counts for turbine meters. This data was averaged over fixed time intervals (daily or hourly) and was stored in archives for later retrieval by host SCADA systems. Later systems performed

required AGA calculations to provide numerous additional parameters used to accurately calculate gross and corrected volumes as well as energy. These enhanced calculations required that the Flow Computer be provided with gas quality data. This data was periodically loaded into the Flow Computer based on laboratory analysis. With the development of robust and reliable field gas analysis devices, systems now may include local gas analysis directly connected to the Flow Computer. In any case, the parameters required for proper gas calculations and reporting consist of a fairly consistent set of parameters recognized by regulatory agencies, accounting systems and gas measurement systems. Some parameters are mostly static such as pipe diameters, pipe materials, altitude any many other parameters. These parameters represent the configuration of a single flow computer and must be uploaded by the data acquisition system only when they change or upon demand by the operator. Gas Quality parameters may be seldom changed or may be scanned, averaged and archived like other gas measurement data. Gas Quality data includes mole percents of most major petrocarbon constituents of natural gas as well as other gases such as hydrogen, oxygen and water. Parameters supplied or required by the flow computer depend on the AGA calculations required. Scanned and calculated flow parameters are fully dynamic and , in addition to archived data, may be required as real-time data for operations monitoring and control.

Several emerging trends within the oil and gas industry have expanded the role of the traditional flow computer so that new field devices now include the capabilities of Remote Terminal Units or Field Controllers. Traditional Flow Computer suppliers have responded by adding extended I/O capabilities to measure other field parameters, an enhanced capability to archive a broad array of non-EGM parameters and vendor provided or user programmable means to locally perform pressure build up tests and control functions. Valve control functions are provided by many of these devices. New devices also provide calculations and collection of liquids data as well as gas measurement data. This explosion in data has placed strains on legacy data acquisition systems and communications media.

While some RTU's adopt variations of de facto standard communications protocols such as Modbus for real-time data, most require proprietary protocols for retrieval of EGM archive data. While many vendors support the established Daniel Extended Modbus protocol for EGM data with optional firmware or hardware, use of this standard seldom provides access to all of the other data available from the RTU. So, even in an age of open interface standards, the process of gathering EGM data and as well as accessing full RTU capabilities still requires dealing with a host of dissimilar protocols. Almost all large operations must deal with numerous different types of RTU's and flow computers spanning the full history of Electronic Flow Measurement. Most companies have strategies in place to replace older units with modern versions due to new regulatory and operating requirements or because obsolete units cannot be replaced or maintained. However, due to cost and logistics, these plans must be phased over long time spans.

The Key Role of the Data Acquisition System

As stated above, the data acquisition (SCADA) system is often the key component in the enterprise gas measurement system. It must acquire both real-time and EGM data using a variety of protocols and communications methods. This data must then be delivered to the upper tier components in a consistent and timely manner. It must reconcile the high bandwidth, fast poll cycle demands of the real-time operations interface with the slower, large data upload requirements of Electronic Gas Measurement. These requirements, and the features of other system components, may be achieved by a proprietary, single source integrated system or the I/O server may be a separate dedicated component that interoperates with the other system components using open system standards. Most new and upgraded systems have adopted the open architecture approach so that each component within the enterprise can be chosen as "Best in Class" or because it most closely matches company objectives. At present, no single vendor offers a comprehensive standard solution for all of the components shown in the block diagram.

The data acquisition system may consist of a single I/O server capable of collecting EGM data or may consist of many I/O servers, each dedicated to a single device protocol. However, the multi-server approach, while common in in-plant systems, is not well suited to systems that must use slower communications methods. As stated above, most companies have a large investment in communications subsystems. Except where field devices of different types are separated to allow dedicated communications for that type of device, most facilities require that different devices share existing communications resources. This is difficult to accomplish using multiple servers because each server usually takes exclusive control of communications ports.

With all of the conflicting requirements from higher tier components and complex communications and protocol requirements at the field level, selection of

the proper data acquisition solution can be the most complicated part of EGM system design. For most systems, the data acquisition system (I/O server) must provide the following features:

The server should be capable of using the full spectrum of communications media.

The server must support use of different device protocols over the same communications path.

The Server should provide an automated means to use secondary or backup communications paths if the primary path is unavailable.

The server should execute as a service that starts with the operating system and runs unattended. It should also be capable of operating in clusters to support redundant configurations

The server must support all of the present and anticipated protocols and devices used for EGM collection and operations control.

The server must provide prioritized I/O scheduling to allow priority handling of operator commands and immediate data requests while maintaining reliable collection of EGM data.

The server should provide a means to schedule regular polling and EGM collection at preset intervals and at specific times of the day to accommodate battery/solar powered RTU's. Communications at these devices are frequently powered down except at certain times or intervals to conserve power.

Support for protocols in wide use, such as Modbus, must provide a complete configuration capability to adapt to vendor specific variations of the standard protocol.

Real-time data must be available by way of the current OPC interface to support the Operations interface. Almost all commercial Human-Machine interfaces (HMI) now support OPC.

The server should be modular so that the user can select appropriate communications and device protocols as needed. The server vendor must be committed to supporting new communications media as they become available.

The server should provide an open standard and toolkit to allow user development of modules to support non-standard protocols. This insures that the end user can always support special devices without relying on vendor priorities.

The EGM collection system must provide uploaded data in industry standard formats including Flow-Cal, PGAS and generic CSV formats.

To support the newest Gas Measurement systems and BTB layers, the server should be capable of writing new EGM data directly to the application.

While OPC has standardized transfer of real-time data, no such universal standard exists for EGM data. Ideally, the server should store EGM data in a relational database or other open architecture to allow direct user access to the data from the Accounting or Gas Measurement systems.

Protocol support for proprietary vendor devices should support all available vendor devices and be capable of accessing all possible features of the device.

The server must provide complete diagnostics and logging to allow rapid identification and isolation of device or communications problems. Diagnostics should be available via OPC to allow display of diagnostics on operator displays.

Logging capabilities should include detailed logs of actual device and port I/O packets to allow resolution of more complex field problems.

Summary

Gathering real-time and EGM data continues to be a critical requirement for business operations in the oil and gas industry. New requirements for more complete and timely data have exceeded the communications capability of older systems. Vendors of Flow computers have responded with new field devices that offer tools or solutions to modern requirements. However the increased bandwidth requirements dictate that systems operate more efficiently than ever. Most companies are continuously revising their communications strategies, field equipment and data acquisition systems to accommodate new requirements. Proper selection of new open standard components, especially in the case of the I/O server, enables companies to phase in new strategies while maintaining collection of EGM data from existing devices.