AUTOMATING GAS MEASUREMENT

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Introduction

This paper will address concepts of SCADA (Supervisory Control and Data Acquisition) Systems and their application to the measurement industry.

An important focus of the paper is to provide the reader with an understanding of the technology and with guidelines to be used to evaluate this equipment as part of an automation project.

Historical Perspective

Since the discovery of oil and gas and the advent of commercial conveniences, powered by oil and gas, companies have been confronted with the need to accurately measure the oil and gas bought and sold in the marketplace. And, as usual, the technology available at that point in time was brought to bear on the measurement process.

All oil and gas companies must deal with measurement and their current technology is positioned somewhere on an automation curve. As time passes, the technology advances and changes. New products and measurement techniques are constantly brought to bear to improve the measurement process. More recently SCADA (supervisory control and data acquisition) systems have become a key technology assisting the user in acquiring measurement data and in controlling the transmission and distribution of oil and gas. Unfortunately, adopting the new technology always brings with it a price that must be paid. And the price is not only measured in dollars, but in ever increasing difficulty in making intelligent decisions and choices.

So how does a company, with a need to move to the next step on the automation curve, sort through the options and complex technology available today? The effort requires a continuing education process. The decision maker must understand not only what the available technology can do for his company today but must understand its future impact on the company.

The Race toward Automation

The oil and gas company cannot stand still, but must continue to push toward increased automation utilizing, in most cases, SCADA technology. Saying “no” to the question "Should I automate or not?" is today not an acceptable option. The answer has to be "Yes" as competition and government regulation requires it. The available computer technology offers us ways to improve measurement accuracy and to reduce the amount of human resource required to manage and accomplish the measurement process. By incorporating this technology, our costs are reduced.

So, faced with the need to automate, the more relevant question is "How do I design my system and choose the proper system components to meet my corporate objectives?"

Problems Faced with Automation

During the course of an automation project a number of questions, issues and problems will surface and have to be addressed. How they are resolved will dictate the ultimate success of the project. Some of the more critical questions are:

- What are the short term and long term corporate objectives? Is the proposed automation step consistent with these objectives?

- What are the shortcomings and inefficiencies in the company’s current measurement process?

- Is the proposed new technology well understood? How closely does it match the desired solution? How much of it is enticing chrome or dazzle which is generally of short-term value. What kind of functionality is "under the hood" that will really help the business over the long haul? Does the technology offer real benefits and meaningful features to the current measurement process?

- Will the technology eliminate or reduce current inefficiencies and costs? If so, how and at what price?

- Is the technology both a good short-term and long-term solution?

Most technological advances are geared toward particular markets and may not provide the best solution for a particular need or application. This can be particularly true with software.

No solution comes without a price. This phrase applies heavily to the measurement system solution and it is imperative that the decision-maker who is responsible for selecting the right system components evaluate all aspects of a particular solution.

A pertinent example is the continuing rush to always adapt immediately the latest innovative technology coming out of Microsoft or other similar leaders to one's needs today. For example, the rush to apply unneeded layers of graphics or new GUI related features to SCADA Systems which, by definition, must support and provide communications intensive functions. Often times this is done at the expense of operational functionality. Benefits of the standardized Windows type GUI point-and-click interfaces are well recognized and are essential in today's systems. Operators not familiar with computers can quickly become computer literate and learn to operate new programs. So what about the on-going long-term price to be paid after the operator has achieved computer literacy and system familiarity? At this point he is now looking for meaningful functionality behind the pretty pictures related to his or her day-to-day tasks. Experience with SCADA Systems shows that added graphic "flash" in an already user-friendly system may just create more layers between the operator and important data and may steal valuable "horsepower" from the communications-intensive system environment.

An objective of the successful automation project must therefore be to keep operational functionality at the top of the priority list.

A common pitfall today in choosing major system components, especially the host SCADA system, is to "turn it completely over to the IT Department". Yes, the IT department is a critical party which must be involved, but a successful project requires that the user of the technology, namely, "Operations" must have responsibility for defining the operational requirements of the system. IT then takes these requirements and has responsibility for assisting operations in finding the best product(s) to meet these requirements.

The scope of the project must be defined at the outset. Is the focus on procuring a total "system" solution or is the decision-maker focusing only on individual components without thought toward how they will be integrated and work together?

A system solution requires the right mix of components and, more importantly, an appropriate amount of system engineering to ensure that the various components play together properly. Is the Company going to do the system engineering? If not, then the level of outside engineering and integration services needed to accomplish this task must be factored into the process. Keep in mind that the level and cost of required outside engineering will be greatly impacted by the software and hardware components selected for the system.

The Challenge

Why is the planned automation path such a risky endeavor? It is risky because getting to the right answers to the questions and issues encountered during the project is not easy. Several major reasons can be identified.

- The technology is changing so fast that even vendors in the business find it hard to keep up.
- Vendors bombard the decision-maker with a wealth of confusing information and complex products, all seemingly designed to solve every current and even future problem.
- Most vendors prefer to sell components and tend to avoid the responsibility of offering a "total system solution" as this requires a diversity of expertise and technologies which typically goes beyond the vendor's product line.

But all is not lost. The following approach or process, if followed, will help the decision-maker wade through the confusion in a constructive manner. This process leads to intelligent decisions based on real data. Key steps in the process are:

- Remain focused on the basics, the Company's objectives, the defined requirements and the desired functional solution.
- Assess and evaluate all available system components in terms of the basics and how they contribute to the overall system solution.

- Ask vendors the right questions.
- Let the accumulated data lead you to the best solution.

SCADA System Components

A technical evaluation of the components in the SCADA measurement system requires that the decision-maker understand fundamentally how they work and what each component contributes to the overall process. The following discussion not only provides this overview, but more importantly, identifies some pertinent system related questions that should be asked as part of the evaluation. Assessing the answers to these questions will lead to the best choices in selecting the system components.

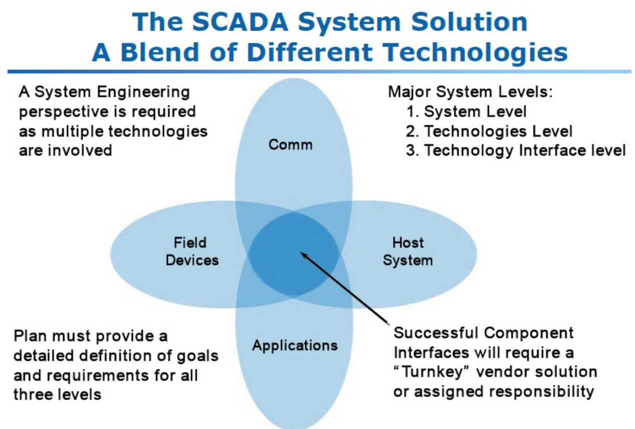

Figure 1. Aspects of a SCADA System

<u>Sensors and Transmitters</u>

The computation of gas flow, i.e. flow rate, through a pipeline by an electronic flow meter (EFM) or a smart transmitter requires various measurement inputs such as gas temperature and static pressure.
Several standard technologies have been around for a number of years. Orifice measurement, the most common, uses the principle that the difference in gas pressure measured in front of and behind a restriction in the pipeline (the orifice plate), is directly proportional to the velocity of the gas through the orifice. This measurement is used to compute the flow rate. A second common technique counts the number of revolutions of a rotary or turbine meter sensor in the pipeline to compute the flow rate. A third and relatively more recent method, the ultrasonic meter, uses the computed velocity of sound (VOS) directed through the gas stream to determine the flow rate.

The technology associated with pressure and temperature sensors is, today, quite well understood. However, advances are continually surfacing in regard to design, accuracy, and cost. Traditional sensors output a current or voltage that is proportional to the measured item and is used by the EFM to obtain the measurement. A new trend today involves "smart" sensors or transmitters with a digital interface. This type of sensor can be useful for applications where the measurements obtained from the sensor or transmitter are the only measurements required from the field. The host SCADA communications system can interface directly to the sensor without requiring intermediate RTU or EFM equipment.

Smart transmitters are available and can be useful in applications such as plant automation. These transmitters actually perform the American Gas Association Report No. 3 (AGA-3) flow rate calculation and maintain a history of hourly and daily flow. These sensors or transmitters, however, may not be functionally equivalent to flow computers (EFMs) unless they fully implement all required calculations, e.g. the AGA-8 compressibility calculation. Use of a smart transmitter may be limited to applications where the gas composition is relatively constant or where the host system can automatically download new composition and compressibility information. Use of smart transmitters with integrated flow calculations can bring improved accuracy and lower cost as they evolve into functional replacements for the traditional EFM.

The ultrasonic flow meter (USM) can offer cost effective benefits in certain applications. The ultrasonic flow meter, although more costly compared to the above more common technologies, offers substantial indirect cost savings as this technology uses sound waves to measure flow rate and therefore does not restrict the gas flow. This can mean real savings in the cost of compressor stations on long transmission pipelines.

Some system related issues associated with transmitter technology are:

- Typical interface between the standard sensor and the EFM is a wiring interface adhering to a standard current of 4 to 20 milliamps or a voltage of 1 to 5 volts, i.e. an analog input interface.

- As the sensor must typically be installed in hazardous areas, equipment must be selected which adheres to applicable ANSI and NFPA (intrinsic safety) standards for those areas.

Electronic Flow Meter (EFM)

An essential component of the measurement system, this embedded computer-based device computes the flow rate based on sensor inputs.

For gas measurement, the American Gas Association (AGA) defines the standard equations to be used for gas measurement. The AGA-3 standard relates to orifice measurement calculations and AGA-7 to turbine meter calculations. AGA-8 provides greater accuracy by adding a more stringent calculation for gas compressibility. AGA-9 defines the standard calculations for the ultrasonic meter (USM) method. AGA-10, using a given gas composition, computes VOS for verifying the accuracy of the USM.

For liquid measurement, the American Petroleum Institute (API) provides standards for liquid measurement.

EFM technology is quite well understood and does not pose much mystery to the decision-maker. There are, however, major system-related issues discussed below which must be addressed when selecting EFM equipment.

I/O (Input/Output) Capacity

The move today is toward integration of technologies to reduce costs. Flow-related data represent only a part of the SCADA information desired from some field sites. Interfaces for compressor alarms, valve controllers, tank level sensors, fugitive emission sensors and other measurements and controls are being integrated for transmission over a common communications link to the field office or central host system.

In the past, both EFM equipment and RTUs or PLCs had to be installed at the same site to gather the required data. This approach also required a duplication of communications media. The need to consolidate all measurement information into the same box and communicate the information over a single communications link will continue to be a priority to reduce hardware and communications costs.

Physical Comm Link Support

The system solution requires that EFM data be uploaded or acquired by the SCADA host system in the user's office. This requires a communications link between the office and the field site. In general, if distance is less than 50 feet, then an RS-232 serial interface between the EFM and communications equipment is acceptable for the communications interface. However, if the site is such that multiple "clustered" devices are present, then an RS-485 two-wire multi-drop interface, wireless or Ethernet interface to the devices can provide a way to interface a single communications link to all the devices. A “Data Concentrator” device can be used in the field to collect data and to monitor the instrument cluster and to report the integrated data and alarm conditions to the host SCADA System over the single link.

Programmability

The selected EFM unit should provide the system user with the ability to easily configure the unit. Ideally, software provided by the vendor should support device configuration remotely from the office.

Archival Storage

The host SCADA or communications software periodically accesses the EFM to upload the archived hourly and daily history information. The EFM must retain ample hourly and daily information to compensate for a worst-case scenario where the SCADA host cannot access the data for a period of time. Most units today will save at least a month of hourly and daily data.

Supported Communications Protocol

Data upload to the SCADA communications processor typically uses a "Master/Slave" polling concept. The SCADA host acts as the master by requesting information from the EFM or slave device. The EFM device responds to the master request message with the requested data. This communications dialogue utilizes a "protocol" or language. This issue is important enough to be discussed later as a key system component.

Hazardous Rating

As the equipment may need to be installed in hazardous areas, equipment must be selected which adheres to applicable ANSI and NFPA standards for those areas.

Data Concentration Devices

Technology is available today to allow multiple devices at a field site to be polled locally by a data concentrator in the field. This device can offer a number of advantages in certain applications:

- Reduced communications costs. Interface to the host system communications software is via a single communications media link to the concentrator.

- Report-by-exception, whereby alarms are reported to the host when they are detected, can be supported by the concentrator.

- Native protocols for the field devices and for the host can be supported. The concentrator can gather data from the field devices using the native protocols of the devices and report the data to the host using the native protocol of the host. This "protocol conversion" function can be very desirable as it allows an already in-place SCADA host to gather data from new devices whose protocol language is not supported by the host.

The Communication Protocol

The communication protocol is the language or messaging rules and format used by the SCADA host and the field devices for communications. It is important to understand that protocol and the type of communications link (serial, Ethernet, etc.) are independent and exclusive entities. Supported communication protocols are an extremely important issue for consideration when choosing both field devices, e.g. RTUs or EFMs, and the SCADA host system. Unfortunately, the required system solution often involves multi-vendor equipment in the field with different protocols. The consequences of this scenario and suggested solutions are discussed later while looking at the SCADA host system component. Here are general guidelines for the decision-maker:

- Use "open" protocols. Avoid proprietary protocols, i.e. a protocol which is not supported by multiple vendors. Arguments that a proprietary protocol is desirable or necessary to provide data security are not significant enough to offset the ultimate cost of this decision. A closed protocol is not necessary to provide a secure interface to EFM data. Many EFMs require a security password to allow login and will reject any attempt to login without the appropriate password. The consequence of a closed protocol is to leave the end-user with no or only a few options for integrating equipment from multiple vendors.

- Acquisition of data from multi-vendor equipment is greatly simplified if a "standard" or common protocol can be used for interface to the equipment.

- Select, when possible, equipment that supports a well-behaved, open protocol, e.g. MODBUS. A well-behaved protocol would be one that supports relatively small message packets rather than large data dumps. Reliable transmission of data dumps over potentially unreliable comm links such as cellular can be very difficult. An open protocol would be one that is non-proprietary, well-documented, and supported by a large number of vendors.

- Make sure the implementation of the protocol is "robust" rather than partial. An EFM vendor may claim to support a particular protocol but in reality cannot provide all the data, e.g. the history information, needed by the SCADA host using that protocol. For example, the protocol may only provide access to instantaneous data and not archived historical data. His access to the historical data may require the vendor's proprietary protocol.

The industry familiar MODBUS protocol can provide an example of these criteria. Access to EFMs can often be by dialup telephone requiring a long distance phone call. The original standard MODBUS protocol, as defined by the Gould Modicon specification, only supported the acquisition of integer data via registers. That is, one could only ask for "single layer" or the current readings from the device. Some time ago it was recognized that this specification needed to be expanded to accommodate the need for floating point measurement data and for "multi-layer" history data. An example of an extended MODBUS definition, which is widely used today, is the non-proprietary Daniel Extended MODBUS protocol and the Enron MODBUS protocol which is based on the Daniel protocol. An EFM supporting MODBUS without these extensions would need to be called every hour if hourly data is needed, whereas, an EFM supporting the history data protocol extensions can be accessed infrequently, e.g. daily or weekly, to acquire multiple hours of historical data. This type of access is essential where hundreds of EFMs must be contacted to acquire hourly data.

However, a vendor indicating support for MODBUS does not adequately define the protocol. There are different flavors of MODBUS. The traditional widely supported MODBUS protocol is today often referred to as "Serial MODBUS", "MODBUS TCP", "MODBUS over IP", "MODBUS RTU" and "MODBUS ASCII". For serial links, the typical standard is MODBUS RTU often called Serial MODBUS. For Ethernet links, the options can be MODBUS TCP or MODBUS over IP (MODBUS RTU over Ethernet). Even though the MODBUS RTU protocol works just fine over IP, a new protocol was invented a few years ago called "MODBUS TCP" protocol. MODBUS TCP and MODBUS over IP are not compatible. MODBUS TCP was invented primarily for process plant automation applications where there was a need for multiple "hosts" to communicate with the same instruments (slaves). In the typical SCADA gas measurement application there is only one host so MODBUS RTU protocol over IP or Ethernet works very well and offers all of the benefits of traditional MODBUS over Ethernet communications. A disadvantage of MODBUS TCP is its assumption that every device will have a unique IP address. This makes it difficult to use an Ethernet to RS485 converter to multi-drop devices in conjunction with the Ethernet as the converter must also do a protocol conversion from MODBUS TCP to MODBUS RTU for the serial interface. A SCADA host and instruments supporting MODBUS RTU protocol over both serial and Ethernet allows the user to choose the best combination of media or links and converters for the host to instrument interface.

The Communications Media

The SCADA host-to-field links can be phone lines, cellular, radio, satellite, and IP interfaces. Selecting the proper communications media for the office to EFM link must first be based on the type of interface required to satisfy company objectives. Do the planned system functions require that the SCADA interface be a dedicated real-time two-way interface to support gas operations and pipeline control functions; or, can the system requirements be met by a once-a-day or once-an-hour data acquisition approach for accounting purposes only. Once the candidate media are defined, the decision is usually based on a consideration of initial installation cost, reliability, and on-going operational cost.

The following system related issues should also be considered.

Site limitations.

Does the site have cellular coverage, satellite coverage, available AC power, or an available phone line?

Data Reliability.

How reliable is the media for data? This is primarily an issue with media such as landline telephone and cellular telephone, which were initially designed for voice communications. Landline modems used in the system should, where possible, support error correction algorithms. Cellular links can suffer special problems such as signal fade or drop and cell switching.

Host Limitations and Issues.

How many communication ports or channels are available in the SCADA host? Each type of media to be used will typically require at least one dedicated port or channel on the host.

Can the SCADA System host software use different protocols and different baud rates over the same communications port?

Can the host software support different poll frequencies over the same comm port? Can the user relax the timeouts in the host if needed to accommodate retry delays in error correcting modems?

Governmental Restrictions.

Is FCC licensing required for the media, as was the case for many radio frequencies years ago? If so, can the license be obtained and how long does it take?

SCADA Host System

Selecting the best SCADA host system software to support the company objectives is perhaps the most difficult task in configuring the measurement or control system. This technology, involving both hardware and software, changes daily. The decision-maker is constantly being enticed to accept new "state-of-the-art" capabilities.

In this environment, some practical advice is to not forget the company's original fundamental objectives and requirements for the system. These requirements will dictate the basic features and functions that must be provided by the host system. A review of these functions or features will quickly reveal whether the candidate system provides a full SCADA functionality or merely a data acquisition/HMI (human machine interface) capability. The decision-maker should assess in detail the level of support provided by the system in the following areas. A full SCADA System will typically provide major features in all of these areas with emphasis on communications and operations-oriented functionality. An HMI system typically provides features for only communications and data presentation with the emphasis, many times, on the latter. Major functional areas which a good SCADA system will provide are:

- Robust multi-protocol support to communicate with multi-vendor equipment.
- High performance communications concurrently (asynchronously) over multiple ports or channels.
- Supervisory control features to support valve and instrument control.
- Alarms monitoring, annunciation, reporting and management.
- Archiving of acquired data.
- HMI data presentation and graphics support.
- Object-oriented design for point and click installation of new devices and communications interfaces.
- Data editing, data reconciliation.
- Data serving, distribution.
- Custom reporting – dynamic vs. rigid design
- Custom applications – dynamic vs. rigid design

The decision-maker must focus on all of these areas. Excluding any one may impose limitations on the resulting overall performance of the system or its ability to meet Company requirements. All of the above system functions should be evaluated by the decision-maker, as they are applicable to even the smallest single PC system with a few EFMs.

No single host system or software package can provide the best solution in each area. Choosing the perceived best in one area may impose constraints in another. For example, choosing an impressive HMI/GUI presentation package with a lot of "flash" may impose serious limitations on operations critical communications and data applications areas.

So how does the decision-maker deal with this dilemma? A good starting point is to define explicitly the current and future requirements in each basic area and then to use this as a yardstick in evaluating each software package. Do not hesitate to press for benchmark information documenting the expected communications performance once the system expands to its largest planned size. From this evaluation, the decision-maker will understand whether a single system package is adequate or whether an integrated system concept is required.

The "integrated system" concept is one where the final SCADA host system is really an integration of several different software packages, each dedicated to a particular system function. For example, front-end communications processors, a master station server, and console stations for the operators can together comprise the SCADA host system. The communications processors handle communications efficiently, the master station has responsibility for data applications, data archiving, data reporting and data distribution functions, and the consoles provide a user-friendly GUI interface for the operator.

Selecting the best host components should be based on an evaluation of available functionality, design, and performance for each of these areas. For example, the master station server should offer a large number and variety of available applications to do the needed data manipulation. Selecting an integrated system from a single vendor offers the advantage of proven component interfaces but a possible disadvantage if it limits the functionality. Choosing to integrate components from multiple vendors allows more freedom in selecting the best functionality but will require considerable system engineering to design, develop and test the interfaces to integrate the system components.

Seeking to answer key design-related questions in each functional area will help the decision-maker identify potential constraints and pitfalls in selecting the host system.

Robust Communicati**ons**

This function is priority #1 in the overall SCADA system. A system with the greatest HMI, graphics, or applications related features is TOTALLY WORTHLESS if it cannot reliably communicate with the field equipment. The design of this function in the control and measurement system is crucial and the capabilities of the selected host software in this area should be closely scrutinized.

The vendor’s operating system platform for the host component should also be closely scrutinized. A continuously operating, reliable and field-proven environment is required. Avoid initial releases of the latest and greatest versions of any operating system until bug-fix (service pack) revisions are available. A nuisance bug in the operating system can bring down your communications and the only fix may be a work-around by the host software vendor.

The communications software component should, if at all possible, be assigned to a dedicated platform with unneeded options de-activated in the operating system. No potentially interfering software should be installed on the platform. Pertinent communications-related questions to ask the software vendor are:

- What is the priority of the communication function relative to other functions and programs such as operator keyboard activity? Can the operator or network-related activity impact the system's ability to efficiently acquire necessary data from the field?

- Does the system provide online communications analysis and audit tools to support troubleshooting? Does it allow the system administrator to capture and review bi-directional communications at the port level?

- What is the practical limit on the number of field devices with which the system can communicate? Can the vendor provide benchmark test data quantifying performance when communicating with the planned number of EFM devices?

- How does one add a new EFM device to the system? Is this task simple or complicated? Are device definitions defined as “objects” or “Apps” for point and click installation?

- Are operator-initiated communications requests handled at higher priority than scheduled periodic communications tasks?

- Can the system support concurrent communications over multiple communication ports utilizing the same instrument protocol and also different protocols? How many ports can be used for concurrent or asynchronous communications?

- Can the system support concurrent interface over multiple types of communications media?

- Can the system use different protocols to communicate with different types of equipment over the same communication port?

- Can the user fine-tune communications by configuring command timeouts, re-tries and polling frequencies at both the command and instrument or device level, or only at the port level?

- Can the system support unsolicited communications or just solicited master/slave communications? For example, can it listen for and respond to a field device reporting a report-by-exception alarm?

- Does the system support automatic and manual download of configuration data such as date and time and gas composition to an EFM?

- After a period of communication failure, does the system recognize the need to automatically access historical data archives in the EFM to acquire all uncollected hourly and daily data?

- Can measurement information from different types of field devices be integrated, archived and reported via meaningful non-vendor/none-device customized reports?

Figure 2 below shows a multi-component project where a SCADA host system is responsible for collecting data from a number of different vendor field devices using different media.

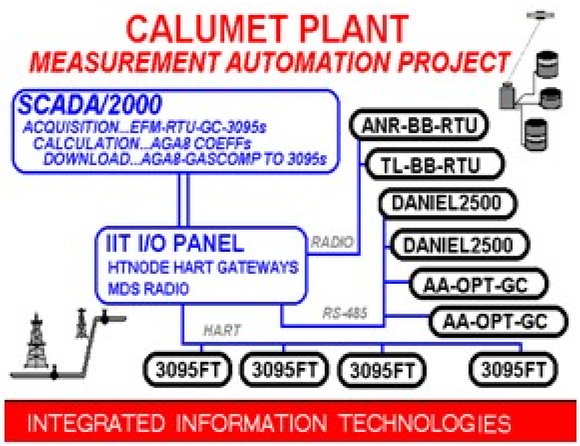

Figure 2. SCADA Host Example

Data Archival

The system must archive all received historical hourly and daily data. Here are important questions for the decision-maker:

- Is acquired hourly and daily data archived in such a way as to eliminate duplicate data should the same data be received more than once?

- Is the data archived and reported with the date/time stamp received from the EFM rather than the time stamp from the host system?

- Can the system be configured to archive the collected data directly to targeted folders on a network server? If yes, are the files treated by the system in a network-aware fashion to allow multiple network users to access the archive files concurrently?

Data Presentation

Data presentation requirements will be to some extent influenced by the available system environment. Whether this environment is Windows, Unix, Linux, or browser-based, the selected HMI interface component for the control or measurement operator should provide a meaningful and user-friendly access to current and archived data.

It is important to understand that the best GUI approach for the trained SCADA gas measurement user is not the familiar GUI approach found in today's world of internet and web browser access to websites. The familiar internet GUI approach is designed for the un-informed/un-trained user who has never seen the website screens before. So the best GUI design for this scenario are simple non-busy screens which require multiple clicks to finally access the single piece of desired information. By contrast, the SCADA gas measurement user must be able to access and review measurement data from hundreds of instruments ideally at the same time and be able to correlate the multiple pieces of data to assess and evaluate system performance and productivity. This means that the best GUI approach here is one with "busy" screens containing as much data as possible and accessible with minimal clicks. Some GUI examples are attached below for reference.

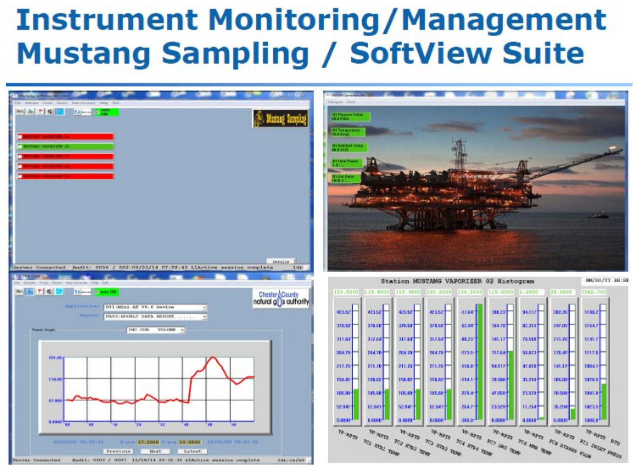

Figure 3. Analyzer GUI Example

Figure 4. Facility / Plant GUI Example

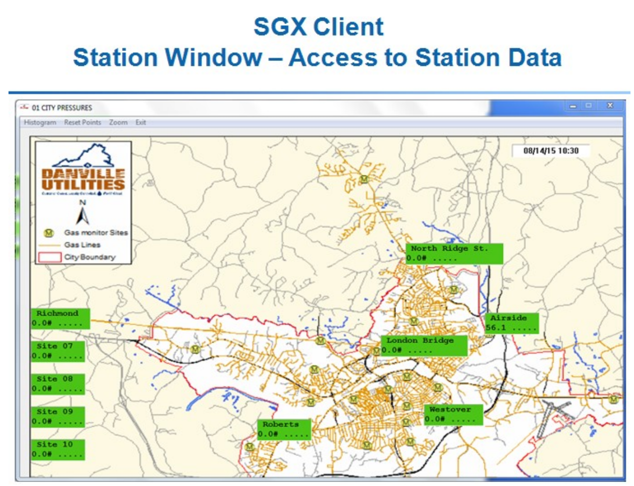

Figure 5. Pipeline GUI Example

Decision-maker questions are:

- Is the operator's access to the information intuitive? How long is the vendor's suggested operator training program? Is it reasonable considering system content? An unusually long program may be an indicator of poor intuitive design.

- Is the data presentation and arrangement logical and pertinent to the operator's day-to-day tasks and function?

- How many layers, or clicks, does the operator have to pass through to access and review desired or correlated data?

- Does the system provide a mechanism for reviewing and analyzing historical data trends, i.e. changes in measurements over time?

- How are detected alarms annunciated to the operator? Can alarms and their annunciation be prioritized from non-critical to critical?

- Can the presentation be customized? Are tools provided with the system to allow the user to implement a hierarchy of custom displays?

The user friendliness of the interface and the functional design features available for interfacing with the archived data are areas of major importance as they define the ease with which daily operator tasks will be accomplished.
Be aware also, that applying Microsoft or other broad industry generic "standards" such as OLE/COMM (OPC), etc. for data exchange and communications in a vertical market such as gas or liquid measurement does not necessarily mean cost savings. These "protocols" merely define lower layers of a language. Considerable engineering work and driver development may still be required to interface to the protocol "API" (applications program interface). Another related problem area is that these broad "standards" are too often short lived and declared obsolete, no longer supported, and to be replaced by a "new standard" by the inventors, e.g. Microsoft before they can gain field proven status in a particular industry. Consider, conversely, MODBUS, a measurement industry standard that has been around for 50+ years and is supported by many vendors. So be sure to accurately assess the real benefits to be obtained when making these decisions.

Data Editing

The selected host software must provide a mechanism for copying acquired EFM hourly and daily data into an area for editing and for AGA or API re-calculation or reconciliation. There will be times when the field data is found to be erroneous and flow rates and volumes must be re-computed in the host system. Examples would be a change to a different size orifice plate and the new size is accidentally not updated in the EFM or a failed pressure sensor. Decision-maker questions are:

- Does the software editing interface prevent the user from modifying raw field data? This is essential, as the field data must, by regulation, be preserved in its unaltered form.

- Is the operator interface to the archive data for copying, editing, and re-calculation user-friendly? Although this is a subjective measure, the interface which the measurement operator uses day-after-day should be logical and easy to use.

- Does the system, in a LAN environment, allow multiple measurement personnel to work concurrently on pre-defined subsets of the archive data?

- Does the system provide an audit function to check received field archive data for consistency and to flag data deemed incomplete or questionable? This function is highly desirable in a system with many EFMs.

Data Distribution

After the measurement data has been reconciled (checked, edited, and saved), others in the organization, particularly the accounting group, need to have access to the information. The mechanisms available in the host system for distribution of this data should be evaluated. Some pertinent decision-maker questions are:

- Can the reconciled measurement data be stored on the network for access by any and all authorized persons?

- Can the data be automatically transferred to the accounting mainframe in a usable format?

- Can the data be automatically stored in a corporate database?

- Can the data be directed automatically to a web server for internet access by customers, suppliers, gas brokers, marketers, and producers?

- What network interfaces are possible with the system? Can the system act as a server to provide data to SCADA clients using interfaces such as MODBUS TCP, MODBUS over IP or OPC?

Custom Reporting

The host system should provide tools and features for installing custom reports or archival automatically and on operator demand. Pertinent decision-maker questions are:

- Are tools provided to allow the user to add a new report or to modify a report without requiring vendor support?

- Can the system automatically direct reports to multiple printers, such as one for measurement reports and one for alarms and audit events?

- Can the system automatically direct reports to a network printer or print server?

Data Applications Platform

Applications or "SCADA APPs" are programs that automate manual tasks. The selected host system platform design should provide available applications and tools for adding custom applications. That is, the system should be "dynamic" and able to grow with the user as requirements change. Typically this would be accomplished via a "script" or macro language support. Ideally, the user should be able to install both new applications obtained from the host vendor and custom applications developed in-house. Some systems today offer the user a large selection of applications from the vendor's applications library, e.g. applications to manipulate and analyze EFM data, to manage gas nominations for gas marketing, and to forecast gas usage. These tools will allow the user to enhance the system as needs change without requiring vendor support.

An additional important issue relating to the overall host system is that of vendor support. Decision-maker questions are:

- How many software vendors are represented in the proposed components of the host system? If multiple vendors are represented, then the interfaces between the software components must be well defined to affix vendor responsibility and to eliminate finger pointing when the need for vendor support arises.

- What kind of support will be available after-the-sale to fix problems or implement enhancements?

- Does the vendor offer an on-going support agreement as a guarantee for support?

In general, obtaining timely and relevant support from vendors for commercial "off-the-shelf" software may be difficult. If the decision-maker intends to utilize this type of software in the measurement process, he should make sure that the software "out of the box" contains the necessary functions and features to meet his current and future expectations.

On the other hand, one should expect and demand quality support from a vendor offering software specifically customized to meet his requirements. The decision-maker should ask for and check references regarding software performance and the quality of after-sale vendor support.

Vendors whose primary product is field hardware may be reluctant to provide software enhancement support. Although some software packages from EFM vendors are highly functional for their equipment, the decision-maker cannot generally count on the vendor to develop driver interfaces to competitors' EFM equipment. Also, as this software is generally offered free or at low cost, the adage "you get what you pay for" definitely applies. These vendors will typically not be eager to implement enhancements. The decision-maker should investigate software sources whose specialty and primary product is the software itself and with a lot of expertise and experience in SCADA.

Host System Architecture

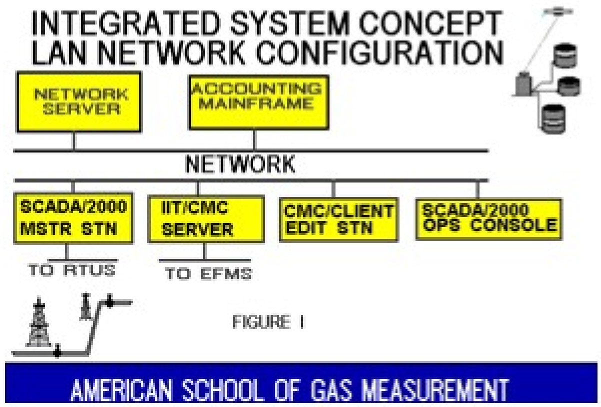

Figure 6. Integrated System – LAN Network

Figure 6 shows an integrated concept gas measurement system configured for a LAN network platform. Component functions are as follows:

- Communications master stations/servers are responsible for collecting and archiving all field EFM data. These stations can also serve as front-end communications processors responsible for the interface to gas control RTUs and PLCs in the field. As the network grows in size, additional master stations can be added easily.
- Measurement data is archived on the LAN Network Server.
- Console stations are used by measurement personnel to reconcile the data. The reconciled data is again stored on the LAN Server.
- SCADA gas control stations provide the gas control functions with communications via the communications servers.

Important advantages of the integrated concept architecture are:

- No duplicate hardware function or communications media links are needed.
- Architecture is applicable to small or large networks.
- Architecture can combine the benefits of a high-performance master station server and communications platform with GUI based platforms for operator stations.

Conclusion

The task of designing, procuring, and commissioning a SCADA System for gas or liquid measurement is complex and tedious. Asking vendors the right questions and seeking information from others with experience will lead to the right system for the decision-maker. The key components and basic features required in the measurement system are the same whether the system is small with a single PC platform or is large with a broad LAN/WAN network. Keep your focus on the operations-oriented functions pre-defined as requirements for the system and evaluate all vendor products in regard to them. This is far more important than being influenced by the day-to-day bells and whistles offered by vendors to hock their wares. Don't be afraid to ask to see “under the hood”.

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