METHODS OF GATHERING EGM DATA

Stephen Easley
TXU Lone Star Pipeline
301 South Harwood St., Dallas, TX 75201

INTRODUCTION

Today's changing world of computers and data communications is an exciting time and is bringing major changes to the gas industry. Especially when evaluating whether to communicate with remote electronic gas measurement (EGM) devices and determining what communications media types will be installed.

COST ANALYSIS AND DETERMINATION/ PRIORITIZATION OF EGM LOCATIONS

The first step to successfully implement a network to remotely gather EGM data is to perform a cost and benefit analysis and determine the 'short list' of locations to focus efforts of EGM data gathering.

It is not uncommon for companies to try to define a cutoff point at which all locations above the cutoff will have remotely gathered EGM data. This method does prove to be a useful tool for a quick review of potential locations for remote data gathering but does not provide a complete benefit analysis.

While some locations may be above the cutoff point due to volume, the location may not be a suitable candidate to remotely gather EGM data because of excessive communication costs. Other locations may not flow large amounts of gas but could have a very inexpensive communication link because of their proximity to a metropolitan area. In some cases, the customer may be willing to cover the cost for communications to ensure availability of data for their review.

To better review candidate locations requires some background research and analysis of the current state at each candidate location. This information will be necessary to prepare a realistic cost analysis when coupled with the different types of EGM hardware, communications media types available and their associated costs.

Items to include in the initial review would include (but not be limited to):

1. Metered volume (annual and monthly). Is there enough usage to justify remote data gathering?

2. Type of information needed and frequency of data gathering? Will small amounts of data be gathered often or will data volumes be larger and more infrequent?

3. Who is using the information? Is information being gathered for Gas Control to control the system, Gas Measurement for billing, or Gas Schedulers for transportation scheduling and balancing.

4. Use of meter? Is the meter used for custody transfer between companies or simply check measurements for the local pipeline network?

5. Type of meter? Is a positive or orifice meter used? Is an EGM device already installed at the location? If an EGM device is already installed at a location, serious attention must be given to the power source. Installation of communications to an existing EGM device will severely impact battery usage. Battery usage is also directly affected by the scan interval.

6. Location of metering facilities? Is the metering location in a metropolitan area where a variety of communication options exist or is the site very remote where only limited types of communication media may be available.

7. Current cost to collect information? What is the current cost to gather and process information including labor, and mileage.

8. Value of information? How will the information gathered be used (i.e., monitor and manage over/ under deliveries and receipts, improve system reliability and throughput, etc.).

9. Are there regulatory or contractual reasons to remotely collect EGM data?

PROTOCOLS

The second major step to be addressed when planning to communicate with an EGM device is the determination of a common protocol to transfer data. A protocol is a defined methodology to exchange information. Different computers, devices, operating systems, and/or software are able to communicate with each other because of the adoption of protocols. The protocol must be common between the host system and the EGM remote units.

Typically, each EGM device manufacturer has its own proprietary protocol. The most common protocol used and generally supported by one definition or another is "Modbus". Modbus is an industrial networking system that uses peer-to-peer communications. The protocol was originally developed by Modicon. Modbus has been modified by different manufacturers to perform specific functions for special projects. Because of these modifications, not all devices that support Modbus protocol can communicate with each other or support all defined functions between the different systems.

There is a new development in protocols for the gas industry that has been developed by the Gas Research Institute (GRI) and the Automation and Telecommunications (A&T) committee of the American Gas Association (A.G.A.) called RAPS (Remote Application Protocol Suite). RAPS provides gas extensions to the UCA2 protocol. UCA2 is a protocol implementation based on the EPRI RP3599 standard for the electric industry. RAPS is an object oriented protocol that adds many enhancements to existing tools and has many advantages over other protocols that have been traditionally available and used in the gas industry.

Use of a industry standard protocol such as RAPS will reduce system costs by avoiding one-time costs to modify existing or to develop new scan subsystems for host systems. Equipment from different vendors can communicate over the same communications network. Installation time will be reduced because the protocol allows remote devices to be self-defining. Object-oriented data objects permit automatic configuration of both devices and systems, resulting in quick application installation. RAPS provides a standard interface to similar products from different vendors so companies can be assured of second sources for hardware. RAPS conforms with international standards: ISO/IEC, MMS, TCP/IP, Ethernet, ATM, ensuring long term support by utility and telecommunication vendors RAPS can be integrated with enterprise-wide networks using most communications media.

Using technology and differing scan implementations, protocol limitations can often be overcome. There are many ways to establish a common protocol. One of the most common methods is to install intelligent devices at remote locations to spoof the local EGM unit by polling the device using its native protocol and actually transfer data over the communications network using a different protocol.

These types of devices are often used as a protocol translator to a host system as well as a protocol converter to support a specialized communications network. A device such as this could be used to convert a native EGM protocol to TCP/IP for integration into a public or private data network.

When an EGM device is used as a system monitoring device, these devices can be used to reduce communications network overhead by continuously polling the EGM device and only reporting by exception to the host system.

COMMUNICATIONS NETWORK

The third major step is to define the communications infrastructure. One of the major issues to be addressed whenever installing a communications network connecting to EGM devices is proper electrical grounding and insulation from the piping system. This topic is covered in many other documents and specifications and is only mentioned here as a reminder.

PUBLIC OR PRIVATE NETWORK

The determination must be made whether the EGM data will be gathered using the public network, a private network, or some combination of the two different types. Typically utility companies maintain a private communications network. There are also many advantages to using a private network. Primarily you can control repair intervals, and bandwidth assignment and usage.

Historically, because of cost for data and unreliability, the public network was often not considered an option for gathering EGM data. However, bandwidth is becoming very inexpensive on the public network and with the advancement of telecommunications equipment, reliability is getting much better on the public network.

After determining the various type of communications media used in your network will help define whether the core data network should be private, public, or some combination.

COMMUNICATIONS MEDIA

The third major step to address when communicating with EGM devices is the communication path, media, and methodology. There are many different options available to establish communications with remote devices. Examples of communication media types include Radio, Spread Spectrum Radio, MAS Radio, Other Radio, Public Leased Lines, Private Leased Lines, Private or Leased Microwave, VSAT Satellite, Cellular Digital Packet Data (CDPD), Dial-up Phone Line, and Dial-up Cellular Phone. These communication media types are discussed further later in this paper.

There are several forces that drive what type of communication media is used. Some examples include:

1. *Cost.* The cost of different communication means varies as greatly as the types of communications media. Some public methods may be as inexpensive as $5 per month and others as much as $300–$400 or more per month. Pricing for some of communications methods on public networks is driven by the volume of (amount being transmitted) data and the frequency of the scan interval.

2. *Availability.* Not all type of communication media is available at all locations. So it must be determined

what types of communications media is available at a given location.

3. *Protocol.* Some protocols are sensitive to the different types of communications media so care and planning must be used when using different types of media. Packet size and timing considerations usually drive this issue. Often times there are parameters that can be tuned in the communication hardware and host systems to eliminate problems encountered in this area.

4. *Device support.* Not all EGM devices support all types of communication devices at this time.

5. *Scan interval.* Some communication media are not well suited for fast scan rates. Scan interval is often related to determining the necessary baud rate to which a communications path must support. The baud rate is a unit of measure of transmission speed, which is the number of “bits” of computer information that can be transmitted in one second. Typical baud rates are 300, 1,200, 2,400, 4,800, 9,600, 19,200, 28,800, and 56,000. As a rule of thumb, divide the baud rate by 10 to get an idea of how many characters (letters, numbers, spaces, etc.) can be transmitted per second. For example, the paragraph you are reading contains roughly 600 characters and would take about 5 seconds to transmit at 1,200 baud (1,200 baud = 120 characters per second; 600 + 120 = 5 seconds).

6. Is commercial power or a power generator available or already installed at the site? Availability of AC power increases the amount of communication options available for a given location. Installation of AC power also eliminates concerns with battery supply and solar panels.

Throughput and speed of data transfer can be affected by data encapsulation, baud rate, and other factors.

RADIO

One of the most key issues when using a radio system for remote data gathering is site selection. Careful planning for both the master radio site and remotes is necessary. Adequate and stable power source, protection from weather elements, and an antennae location with an unobstructed path in the direction of any remote locations are necessary requirements for the master station.

Before permanently installing radio equipment, a site survey should be performed. The survey can be performed using computer software or actually setting up the master radio and manually checking a remote location with a portable transceiver. Manually checking a location is obviously the preferred and most accurate method.

Licensing. The rules of eligibility for licensing of a radio station are contained in Part 90 of the Federal Communications Commission (FCC) Rules and Regulations. Most gas utilities who engage in the distribution and acquisition of natural gas are eligible under Part 90.63 (Power Radio Service). Natural gas pipeline companies who engage primarily in prospecting for, producing, collecting, refining, or pipeline transportation of petroleum or petroleum products (which includes natural gas) are eligible under part 90.65 (Petroleum Radio Service).

A copy of the FCC Rules and Regulations should be consulted to determine the frequencies that are available for the intended application.

The FCC has divided the frequency spectrum into user bands. The Frequency Coordinating Committee is allowed to assign a frequency in a given bandwidth designated for a particular type of usage or industry to another type of industry. However, the industry to which the bandwidth was originally designated may bump the company to the frequency assigned if that company is not part of the given industry.

Spread Spectrum Radio is a newer radio technology that requires no FCC licensing. When properly installed spread spectrum radios provide high data integrity. Generally, the radio modems can be equipped with error detection or correction. Protocols are transparent to the communications media and path.

Spread spectrum is a communications method where a radio frequency signal is modulated (spread) a second time so as to generate an expanded bandwidth wide-band signal.

Spread spectrum radios typically use the bandwidth between 902–928 MHz. Digital radios use either frequency hopping or direct sequencing within this range to ensure maximum performance and maximum reliability for SCADA communications.

Typical data transmission range is a clear line of sight. Line of sight can be as short as approximately 1–1.5 miles using whip antenna. Ranges are common at 10–12 miles with directional antenna and as much as 40–50 miles using directional antenna and repeaters. Of course, the distances are affected by the local terrain. Dense trees and metropolitan areas greatly affect the effective range of spread spectrum radios.

The effective range can be increased using higher gain antenna systems, repeaters, or with the addition of an amplifier, however radiated power rules must be followed. The spread spectrum radio system will provide a transparent point-to-point type transmission medium for data communications. The typical interface to a spread spectrum radio is RS232. Data rates are often 19.2 kbps, and higher, even with weak signals and in the presence of interference.

A ***Multiple Address System (MAS)*** radio system is designed with a central control (master) station that exchanges data with numerous remote (geographically different) locations. This type of radio system must be designed in accordance with Federal Communications Commission (FCC) regulations and FCC licensing is required. This type of system must also be designed in accordance with Federal Communications Commission (FCC) limitations on effective radiated power (ERP).

The master station typically has an internal "hot-standby" backup radio to provide a high level of reliability to acquire data from remote locations. The coverage area is defined by the host radio antennae type, height, ground elevation, and terrain. Applications for permits to build new antennas taller than 300 feet may have to include an environmental-impact study.

The type of antenna at the remote is dependent on government-imposed height limitations and antenna directivity. Typical remote antennae height is 25 to 90 feet.

The MAS radio system will provide a transparent point-to-multipoint transmission medium for data communications. The typical interface to an MAS radio is RS232. Data rates are typically 1.2–19.2 kbps. Protocols are generally transparent to the communications media and path.

OTHER TYPES OF RADIO

Other types of radio communications are often used at EGM locations. This media is acceptable for data gathering and supervisory control, but signal fade and attenuation can affect performance and reliability. Federal Communication Commission (FCC) licensing restrictions and limited spectrum availability in certain metropolitan areas also must be considered.

The gas industry uses communications radio frequencies in the 30-MHz to 960-MHz range, which comprises the very-high-frequency (vhf) band and the low end of the ultra-high-frequency (uhf) band. The equipment used is generally small in size, requires little power, and provides communications without the use of wires. The frequency spectrum available for use by the gas industry is scarce, and, consequently, it must be allocated and used efficiently.

The typical interface to a radio is RS232 or RS485. Data rates are typically 1.2–9.6 kbps. Protocols are transparent to the communications media and path. Protocols are generally transparent to the communications media and path.

PRIVATE OR LEASED MICROWAVE

Microwave communication systems typically use radio frequencies at or above 960 MHz. Because of its extremely high frequency, a microwave signal behaves much in the same way as a beam of light. The signal is focused by a parabolic antenna and sent from one point to another in a manner similar to shining a light beam. The requirement for line of sight between the transmitting and receiving antennas is more pronounced in microwave communications than in other radio communications.

The microwave radio signal is the carrier on which multiple channels of information can be impressed by various modulation and multiplexing techniques. Voice, data, video, and other communications intelligence can be transmitted in this manner. Typically, a microwave system will have from 1 to 600 channels.

It would be difficult (if not impossible) to justify building a private microwave network simply to carry EGM data. However, many utility companies already have such systems in place making them an inexpensive communications media to back haul EGM data. If a private microwave network does not already exist, often times an inter-companies agreement (contract) can be placed in service allowing a company to lease space on another company's microwave system. This is especially beneficial where public wire lines do not exist. If public wire lines do exist and no microwave is available, they are usually the most attractive alternative.

Public Leased and Private Dedicated Lines. With technological advances coupled with more customers using leased facilities for data, reliability of the public network is increasing while its cost is decreasing because of abundance of bandwidth. Dedicated private lines for exclusive use are generally more expensive to install and maintain than other types of communications media. They should only be used when continuous communications are required, public facilities are not available, and other communication media is not available, is cost prohibitive, or cannot support a high enough volume of data.

Dedicated leased or private analog lines are generally four-wire, full duplex circuits providing data rates from 1.2 kbps. to 56 kbps. (56k). Digital lines generally provide data rates 56 kbps. (56k) and higher.

Dial-up Phone Line [POTS (plain old telephone service)]. If a continuous link is not required, a dial-up circuit may be used. Data might be transmitted at certain times of the day for a brief period. An example would be to dial up a location on an hourly basis using a normal phone lines or WATS line. Normally, the cost of using a dial-up circuit would be less than that of using a leased circuit, but frequent long distance calls on a dial-up circuit can quickly exceed the cost of a leased circuit.

Dial-up (POTS) lines are generally two-wire, half duplex circuits providing data rates from 1.2 to 28.8 kbps. In some locations, however, dialable digital data services (i.e., ISDN) are available that provide 56K bps and faster data rates. Dial-up modems are typically built into the EGM device or use an RS232 interface. Protocols are transparent to the communications media and path.

Use of ***Dial-up Cellular Phone*** is very similar to using POTS service at a location. Dial-up cellular is a convenient communications media because of the wide area coverage now offered to cellular telephones and installation of wiring facilities is no longer required. Data rates are typically much slower than most other communications methods. Another disadvantage in use of dial-up cellular is that charges are based on minute usage and always round up. In other words, depending on your contract with the supplier, a single call could have an additional 19–59 seconds added due to rounding. When placing frequent calls to a single location this additional time could be significant.

Dial-up cellular modems are typically have an RS232 interface. Data rates are typically 1.2–7.2 kbps. Protocols are transparent to the communications media and path.

***VSAT Satellite*.** Very Small Aperture Terminal. (VSAT). An earth station with a small antenna of usually 0.9–1.8 meter (3–6 foot) diameter. Typically used in point-to-multipoint data networks.

A communication satellite functions as an overhead wireless repeater station that provides a microwave communication link between two geographically remote sites. Due to its high altitude, satellite transmissions can cover a wide area over the surface of the earth. Each satellite is equipped with various transponders consisting of a transceiver and an antenna tuned to a certain part of the allocated spectrum.

C-Band Satellite operates in the 4 GHz to 6 GHz frequency range. It is susceptible to terrestrial microwave interference, which is a particular problem in cities and urban areas of worldwide coverage, and is less susceptible to rain and weather fades, than KU-band. The use of C bands was most common in 1st generation Satellite systems. However this band is already crowded as terrestrial microwave links also use these frequencies. The current trend is towards the higher frequencies of KU and KA-Bands. C-Band is an older satellite technology and not frequently installed at new installation.

KU-Band Satellite operates in the 12 GHz to 14 GHz range. It can support data, video, and voice with smaller dishes than C-band. More susceptible than C-band to problems arising from atmospheric conditions such as rain fade, but less susceptible to terrestrial microwave interface.

KA-Band Satellite operates in the frequency of the 20–30 GHz range. It is in the experimental stage and will allow the use of terminals with even smaller antennas than KU-band. Spectrum availability is also significant.

Cellular Digital Packet Data (CDPD) is an open standard wide-area network that overlays the cellular telephone infrastructure to enable remote users and devices to transmit and receive data in a wireless environment using the Internet protocol TCP/IP.

For systems that do not support TCP/IP, some modem manufacturers will encapsulate the native protocol into IP using UDP for transport across the CDPD network. The IP is then stripped from the native protocol at the receiving end and the data is passed to the end device or host transparently.

Most CDPD modems will function somewhat as a dial-up modem. If the host system and remote EGM devices support dial-up networking and will allow the telephone number to be replaced with an IP address and the remote location is in an area covered by CDPD, the host will be able to scan the remote using its native protocol without direct IP support. This is another method CDPD modems can encapsulate a native protocol.

CDPD coverage areas are not as large as cellular telephone coverage. CDPD monthly operating costs are typically $5 for infrequently scanned locations but can be as much as $55 per month for frequent scans with large quantities of data.

CDPD radio modems typically have an RS232 or RS485 interface. Data rates are typically 9.6–19.2 kbps. TCP/IP is used as the transport protocol across the CDPD network. CDPD locations can usually be accessed via the Internet. Protocols are not transparent to the communications media and path and require encapsulation in or full support of IP by the devices and applications.

Stephen Easley