The Evolution of Data Collection for Gas Measurement

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Evolving communication technologies are revolutionizing SCADA (Supervisory Control and Data Acquisition) systems just as new technology in drilling and production are revolutionizing the way oil and gas wells are produced. The new high volume pad wells and horizontal production techniques demand:

- Faster data collection
- Systems that provide more detailed information
- Greater polling speed
- More remote control
- Ability to optimize production to lower operating costs
- Equipment that is lower cost, and easier to install than ever before.

In today's oil and gas environment, production volumes are many times greater than they were just 10 years ago. The price of these resources is down significantly from where it was in 2008 so, for producers, it has become increasingly more important to run more cost-effective operations.

The new economy and new production volumes require:

- Reduced down time
- Maximum production
- Maximum manpower
- Real time decisions
- Real time data
- More frequent data
- Real time alarms

Older SCADA systems often communicated once a day to provide custody transfer data back to a field office, Radio systems often communicated at baud rates of 4800 or 9600 bytes per second. These systems all were limited to serial communications (one conversation at a time). Many systems took one to two hours to collect data from 200 wells (see diagram #1). Additionally, the characteristics of these wells, such as casing pressure, plunger position, valve position, tank levels etc., often were not carefully documented, making optimization difficult. In some cases, casing and tubing pressures were not reported back to the office so valve control was accomplished by a mechanical timer on location and tanks had to be gauged by hand daily. Most of these wells produced less than 1,000 cubic feet of gas per day.

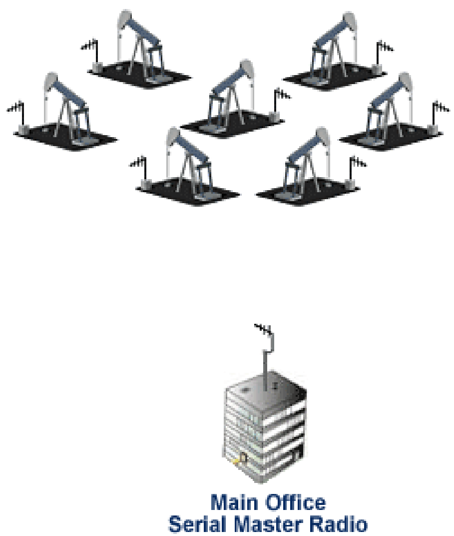


Diagram #1

Today, thanks to new technologies in drilling and production, we have wells that can produce more than a million cubic feet of gas per day. Most of the new “shale play” gas is being produced on pads where 10 or 12 of these wells use one production facility and one tank battery. Decisions regarding which well needs to be shut in and which valve is to be opened must be made by computers on location and these decisions must be communicated to the wells instantly. The production data and the plunger lift data for production optimization must be collected from multiple pads as quickly as possible as lost production at these volumes can be extremely costly.

Consequently, producers have been challenging communications companies to create solutions for these new locations. These solutions must provide:

- Communications from an EFM (Electronic Flow Meter) to multiple wellheads.
- Communications from central tank batteries to the EFM.
- Communications from multiple well pads to a central collection site.
- High speed, secure, web-based communication backbone.
- Wireless valve control.
- Wireless casing and tubing pressures.
- Real time alarms.
- Communication with multiple sites at the same time.

Several communication companies have responded with partial solutions, while some have responded with multiple products that can be integrated into one seamless solution to address all of these needs and categories with one suite of products. It seems there are as many automation products these days are there are grains of sand in Frac job. These products break down into four categories:

Well Head Communication

This might be called the instrumentation layer of communication. The radio in this category must be able to take instrumentation signals such as:

- Analog Signals
  1. Casing Pressure
  2. Tubing Pressure
  3. Tank Levels
  4. Temperatures

- Digital Signals
  1. Valve Open
  2. Valve Closed
  3. High/low level switch
  4. Oil pressure switch

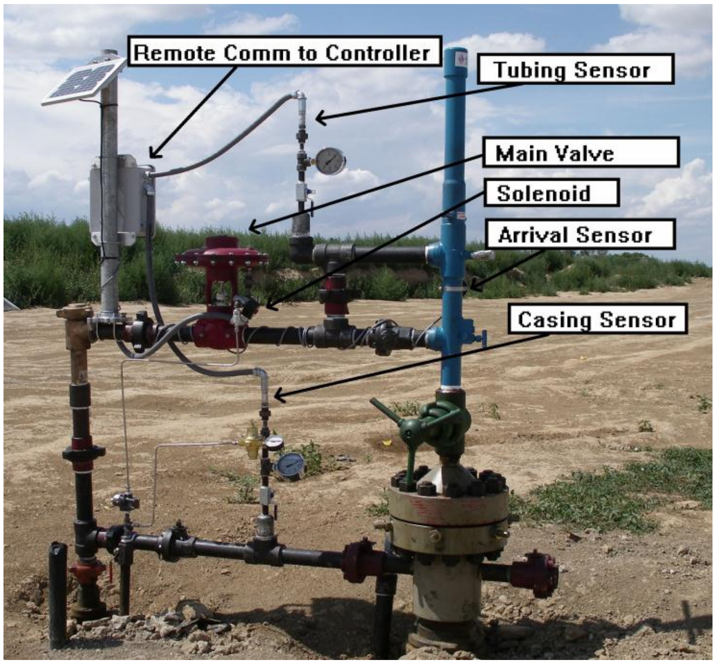


Diagram #2

Well Site Communication

This is the communication layer from the EFM back to the data concentration point or 'backbone' layer. This layer typically will have hundreds of wells bringing data back to a central collection system.

This radio can either be Serial- (RS-232 or RS-485) or Ethernet-based. With the controller and EFM manufacturers releasing new generations of smart field hardware, there are more options available, and many of these are incorporating faster download speeds to enable better polling and response times.

While instantaneous gas measurement may only require 500 to 1,000 bytes of data, 24 hours custody transfer records and plunger lift information can be 10 times that amount of data (5,000 to 10,000 bytes). As a rule of thumb, it is best to have the radio transmit (download) faster than the EFM or controller is passing data to the radio. For example, if the EFM can handle 19.2 kbps and the radio transmits 115 kbps, only about one-fifth of the available bandwidth is being used as well as having space (time) available for retry transmissions and for real time alarms from compressors, tank sensors, line pressure monitors, etc. Obviously, the more wells it is trying to talk to, the more important the radio's transmission speed becomes.

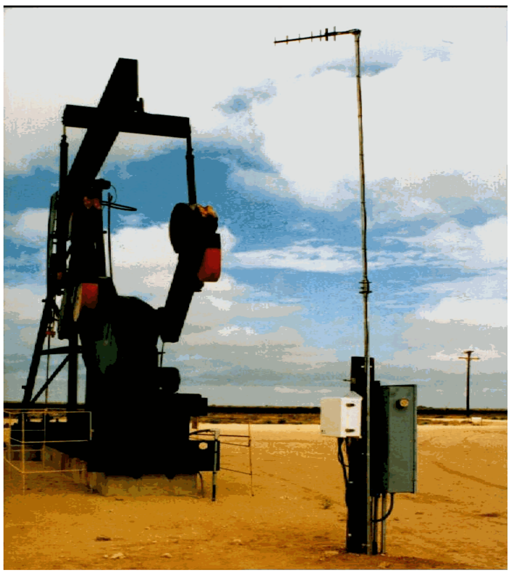


Diagram #3

Medium Speed Backbone

This radio will be Ethernet-based. Typically, this radio has larger bandwidth (higher throughput) that can consolidate data from multiple wellhead networks. These products are typically in the one megabit range. Each network can have from a few dozen well pads to a hundred well pads each with multiple wells. This allows the use of IP addressing and the ability to poll multiple networks at the same time (See Diagram #4).

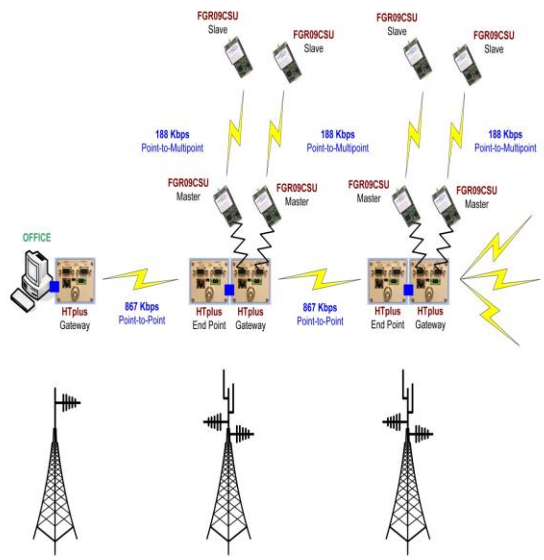
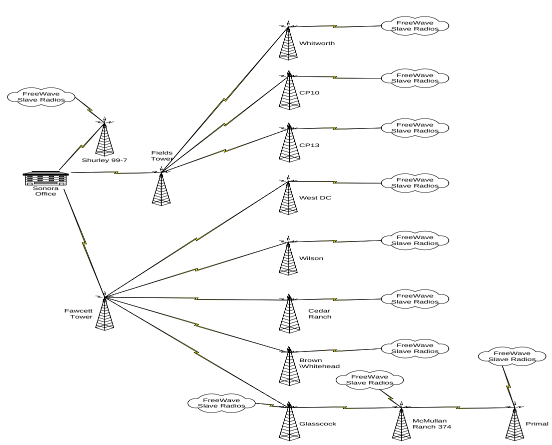


Diagram #4

Back Haul

This layer of communication may be Internet access, phone lines, microwave or high speed Ethernet. This layer can consolidate multiple backbone networks. Many radio manufacturers are working with high speed communications specialists to provide backhaul capabilities of 40 to 50 megabits per second. This is the oil and gas equivalent of bringing gas from a six-inch line into a 24-inch line. In each layer of the communications, system speed becomes more important. As it moves downstream, more and more relatively small flows of data are joining the network. Having the capacity to combine these multiple streams becomes a make or break criteria for the communication system.

Additionally, the back haul must be capable of delivering data wherever it is needed. That may be dozens of miles away, hundreds of miles away or even thousands of miles away.



While some producers have an extensive staff of gas measurement specialists, production optimization specialists, communications experts, and an IT department familiar with field data collection, many companies have a limited number of people who have to wear all or many of these hats on a daily basis. For any company trying to build a data collection system, this complex task can be daunting and for companies with smaller staffs it can seem overwhelming.

Finding products to perform all four of these functions is relatively simple. Integrating them to work together is much more complicated. Many producers have chosen to use a manufacturer that can offer compatible products made specifically for these applications. These manufacturers make products designed for oil and gas applications. The products have very low power consumption because almost all well site locations require that power be supplied by solar panels and batteries. Producers report that the difference between power consumption on competing products can cost them as much as $400 per well. On multiple well pads, that quickly can become thousands of dollars, and in multi pad fields it can become hundreds of thousands of dollars.

The “state of the art” of this new technology uses communications protocols, such a “Modbus,” and has the ability to handle multiple wellheads and multiple well pads on one system. This system also has the ability not only to communicate with the wellhead and the well pad, but, also to make the long haul over many miles from the pad to the communication backbone. These well site radios must integrate seamlessly into the backbone and handle not only the collection of the measurement data, but provide communications radio diagnostic data for the end user to be able to remotely monitor the health and viability of the network.

Economics

One of the key components to a successful communications infrastructure is cost. There are two key components to cost: First, what is the install cost and how does that compare with other alternates, such are hardwire, trenching and conduit, etc. Additionally, it is important to consider the life-time cost of ownership.

Installation costs should include the cost of the wireless device; the cost of the power system to run it; and, the time and cost to install it. Here is an example of a wireless wellhead versus a wired wellhead.

<u>Wired wellhead:</u> Call a contractor to trench from the wellhead to the EFM. Typical cost is $16 per foot trench. Trench from 10 wellheads back to the EFM, plus trench from the tank battery to the EFM. Typical total trenching distance 1,600 feet at $16 per foot equals $25,600. The time needed to complete this installation is five days.

Wireless wellhead; Cost to install wireless radios, batteries and solar kits $1,000 times 10 wells equals $10,000 Tank battery costs $1,000. Total hardware cost is $11,000. Time to install is one hour per wellhead times 10 wells equals 10 hours.

Lifecycle cost: This can vary, depending on which manufacturer's equipment is installed. Some manufacturer's radios only use seven milliamps of current draw, meaning they can power the radio and the sensors (casing and tubing pressure) with a seven amp hour battery and a five watt solar panel. Other manufacturers may draw 70 milliamps and require a 100 amp hour battery and 60 watt solar panel to do the same job. The differences in install cost would be about $400 per site, but if life cycle costs are considered, the battery must be changed every five years (manufacturers recommend two to three years) and if the system is operational for 15 years, that will add another $800 per location to the life cycle costs. With producers talking about drilling a thousand wells per field in these new shale play areas, power consumption of this one product could mean a million dollars difference over the life of the system.

Summary

In our evolving world of oil and gas production, more data is being requested more often, Old 9,600 baud analog style radios can't keep up with the new demands. Almost continuous polling and higher transmission speeds are requiring communications systems to evolve from a single network solution into multiple networks, each of these networks provides layers of communication. To create these multiple layers requires multiple products. Layer #1 is wireless IO between wellhead instrumentation and the EFM or controller. Layer #2 is communication from the controller or EFM to a larger backbone communication system that can cover the entire geographic area of the field. Layer #3 is a backhaul communication system that can take the data from the field to anywhere in the world where the data may be needed.

These layers must have common interfaces and the ability to pass data seamlessly between them.

Critical factors in each layer include the following:
Layer # 1

- Sufficient IO count to bring all the needed information from the wellhead instruments, such as: Casing pressure, tubing pressure, valve control, tank levels, etc. This must be low power for battery and solar installation.

Layer #2

- Communications from the EFM or controller to the backbone. This radio must be faster than the port speed of the EFM and be low power for battery and solar applications

Layer #3
Communication from the backbone end point to the backbone gateway. This consolidates multiple layer #2 networks and must be in the one megabit range for

throughput. This should be relatively low power as it will often be powered by battery and solar.

Layer #4

- Backhaul from the backbone layer to IT departments and production management. This layer has to have very high throughput and almost always will be Ethernet-based. Typically these points should be selected where AC power is available as they tend to be to power hungry for economical battery and solar installations.

More pre-planning and system design are necessary to build an expandable scaleable communications network. These systems are much more complex than the older systems, but provide far greater versatility and are far more robust than the systems built 10 or 15 years ago. Considering how far production technology and communication technology has come in 15 years, it will be interesting to see where it will be 15 years from now.

Author Bio:

Jim Gardner is the oil and gas team leader for FreeWave Technologies, Inc. Prior to joining FreeWave; Gardner was vice president at Remote Operating Systems. Gardner graduated from the University of Washington in 1975 with a Bachelor of Arts. Gardner is currently a member of ENTELEC, ASGMT and ISHM. For more information please call 866-676-4046.