Applying Technology and Lessons Learned from Gas Well Monitoring to the Electric Grid

New technology developed for gathering data from remote gas wells and up-linking to the Web can be applied to the electric grid.

By Jack Smith and David Silvers

Robust technology and meter hardware is now available for reliably monitoring and operating natural gas wells from a central or field office. Gas wells tend to spread out in regions where natural gas exists creating a challenge for manual monitoring and maintenance. A company founded in 2003, Silversmith, Inc., has developed a new technology for efficiently and cost effectively bringing the remote data back to a web server base. The company has now installed over 7000 meters across the U.S. and Canada. While the company has many competitors that also do web based metering, a key element of its success is the smart and proprietary method it uses for data collection in a gas field.

Gas wells are typically located in rural areas and are usually located on at least 40 to 80 acres each. So a square mile will hold a maximum density of 8 to 16 meter sites. In many areas where natural gas is found, the spacing is much less dense than this. Typically at a gas well site there is no electric power or hard wired communication line available. So an electronic monitor must be totally self sufficient both in terms of power and internet connection. If money were not an object, bringing data back from every well wouldn't be a problem. A meter would be powered by battery with a solar power recharger and it would shoot the data back via cell modem from each well. However, this is not necessary. A cell modem costs approximately $400 and usage fees range from $40 to $80 or more depending upon how much data is being transmitted and how often. If a satellite solution is employed (as in where cell modems are ineffective) the cost is more in the area of $2000 and $125/month. So minimizing the use of cell modems is key to providing customers with a cost effective solution.

The core technology

Most gas monitoring companies use a system called "discovery" to connect each well to a internet uplink. A signal goes from the central office server – out to the internet site - with an instruction such as: "looking for Well 23 to report in!" A radio at the internet site broadcasts this to all the wells around it, which in turn rebroadcast the request, and so on. As these radio signals radiate outward, more and more meters are woken up and asked to relay the message. Ultimately, Well 23 gets the signal and says: "It's me! Time to report in.". Then, Well 23 starts the process in reverse sending signals and waking up other monitors and their radios until it rediscovers the home base for that field where the whole process started. Using this "*Discovery Method"* in a field with say 30 wells there might be as many as 60 radio transmissions, all drawing precious power from their batteries. When you take a look at what radio signals were really required, it would only be small a fraction of all the transmission signals made. For example from Home to Well 5 then from Well 5 to Well 10 then to 15 to 20 and finally on to Well 23 the desired target. In this case, out and back is only 10 transmissions or hops.

That, in essence, is the proprietary technology used by Silversmith. The exact best route to Well 23 is pre-mapped in the centrally controlled software for this field. That route: Home, 5, 10, 15, 20, 23 is built-in as the best route to get out to Well 23 and back. The route is built with knowledge of the field and its contour so the signal can negotiate around hills or trees or obstructions. Why try to radio through the trees when you can more easily go around them? For added reliability, several backup routes can be programmed so that one meter that may be down from lightning or other factors won't impede overall communication. The company's products are built around this communication protocol which is patented.

In a baseball analogy, imagine coaching a young team that if a player hits what looks like a double, just run to any base and see if it's second and if not, run to another one and keep doing that until you find second, but if you haven't visited first just before second, be sure to do that! This would politely be called: *Player confusion.* Yet that's what the *discovery method* really is in mesh network communications!

With the Silversmith communication protocol, huge savings are possible because of the number of individual wells that can *report in* through one internet access point *and* the smaller battery size and solar panel recharger that is enabled. In one gas field near Calgary, Alberta, 350 wells communicate with virtually perfect reliably through <u>one</u> access point! We have not seen this possible with *discovery methods*.

Data Collision – the other problem

In a field with numerous wells, the *discovery method* will often bog down under all the radio transmissions that are occurring. The resultant *data collisions* create holes in the data stream and the need for rebroadcast attempts. More power wasted and wait times for the user who wants the data. The company is often called in to solve these problems and is almost always able to do so.

In fact, this has occurred so often that there developed a need to pluck the core communication element from our normal offering of meter hardware and web interface and just provide the field communication piece. This evolved into what is now called the Silversmith Link Board. This is a stand alone box that attaches to our competitors' meters and more efficiently brings the data back using our core communication technology. It allows customers to continue to use the well monitoring assets they have invested in but solves the communication issues they may be having. Initially, the Link Board product had to display data on a Silversmith's user interface, but now the architecture has been made further flexible and can display on virtually any mainstream user interface (Wonderwear, Rockwell, Cignet, etc.)

If it works for Natural Gas, why not the Electric Grid?

Now we get to the heart of this paper and audience it is directed at. The technology has now been developed and is available to take on applications for remote monitoring in the Electric Grid. In the March 2010 issue of Renew Grid magazine the following table was provided, the source being EPRI.

Transmission and Substation Sensor Technologies

Area	Component	Sensor
Substations	Substation-Wide	Antenna Array
		On-line Infrared
	Transformer	MIS Gas Sensor
		3D Acoustics
		Acoustic Fiber Optic
		Gas Fiber Optic
		On-line FRA
	Load Tap Change	LTC Gassing
	Post and Bushing External Insulation	RF Leakage Current
	Disconnect	RF Disconnect
	CTs and PTs	RF Acoustic Emissions
	Breaker	RF SF6 Density
Underground Lines	Oil	MIS Sensor
	Underground Cable System	Various
Overhead Lines	Compression Connector	RF Temp and Current
	Conductor	RF Temp and Current
	Insulator	RF Leakage Current
	TLSA	RF Leakage Current
	Shield Wire	RF Fault Magnitude and Location
		RF Lightning
	Structure	Sensor System

Source: EPRI

10 Renew Grid ■ March 2010

As this table shows, there is a wide list of possible applications for monitoring and creating improvements in the Grid in areas such as:

- Safety
- Workforce deployment
- Maintenance
- Problem diagnosis
- Asset management

In a substation, sensors would communicate back to the internet access point using other sensors in the local *mesh* to route the data. The pre-ordained path specified and centrally controlled will allow clean communication with minimal radio traffic and confusion.

To achieve a truly smart grid requires that the smartest communication network be deployed, one that is simple but with proven effectiveness. This network protocol is now proven albeit in a different operating regime, natural gas production. The tool is adaptable to most sensor outputs and is "connectable" to almost any user interface. The company looks forward to application requests in the electrical grid arena and sensor partners who wish to improve their communication effectiveness.