Originally appeared in World Oil® SEPTEMBER 2015 issue, pgs 75-78. Used with permission.

In the digital oil field, "no wires" is a no-brainer

North John Elk 28HC, a single producing well in Dunn Co., N.D., was the site of WPX Energy's wireless pilot test. Photo: WPX Energy.

Wireless networks are changing the way that producers look at wellsite optimization. And in the Bakken shale, where operating conditions are among the most difficult in the world, a pilot test conducted by WPX Energy showed how wireless is increasingly becoming a preferred method.

ZACH WERTENBERGER, WPX Energy

Wireless technology plays an integral part in the day-to-day operations of virtually every industry on the planet. However, if you spent your time visiting most of the world's oil fields, you wouldn't believe that.

Despite being a rather obvious fit with the inherent nature of the oilfield services sector (OFS), wireless I/O has been adopted by producers at a slow pace, with most continuing to rely upon miles and miles of fault-prone wire to connect onsite control centers with wellsite instrumentation.

In a field where safety, productivity and ROI are the determining factors in every decision, this is beginning to make less sense. Hardwired communication systems are costly, maintenance is intensive, and it all is misaligned with the growing need to reliably deliver real-time operational data throughout a geographically dispersed workforce. In more recent years, soaring electrician rates and harsh working conditions, especially in remote areas, also have made them more unfounded.

Though long overdue, all of these shortcomings have finally forced operators to start asking a very simple question: Why, in 2015, has wireless I/O not overtaken hardwired infrastructure as the industry standard throughout the OFS sector? As WPX Energy discovered in the Williston basin, the answer is that there is no good answer.

WHERE HARDWIRED SYSTEMS FALL SHORT

When it comes to wellsite optimization, communications systems are an area often overlooked by producers. Because of this, hardwired instruments are still prevalent in most of the world's oil fields. Their inefficiencies, however, are becoming hard to ignore. This is especially true in areas like the Bakken, where the high demand for skilled contractors has pushed the cost of electrical work through the roof.

Long, harsh winters in the region also make it difficult to perform routine construction tasks, such as trenching, burying conduit and pulling cable, which are all required to hardwire a site. Underdeveloped infrastructure complicates the commissioning process even further, as wires often have to be run long distances to be tied in with control centers—pushing labor and material costs even higher, and ultimately increasing time-to-production.

Reliability also has become an issue with hardwired instrumentation, and not just in the Bakken. Corrosion, humidity, excavations and physical loading from traffic are all common sources of wire failures. Consequently, when wires fail, instruments fail; and when instruments fail, wellsite equipment has to be shut down; and when wellsite equipment has to be shut down, productivity plummets.

Radio signals, on the other hand, don't corrode. They aren't affected by excavations or harsh environmental conditions, and with self-organizing mesh networks (i.e., WirelessHart), physical obstructions are not problematic. They also don't require maintenance from electricians charging increased day rates. In fact, in most instances, troubleshooting can be performed by a technician sitting in an office hundreds of miles away.

CHANGING THE BAKKEN STATUS QUO

In 2013, WPX Energy was experiencing challenges with hardwired instrumentation, first-hand, in Dunn County, N.D. Sitting at the heart of the Williston basin, North John Elk (NJE) 28HC is a single producing well that was originally wired with high, and low, pressure transmitters, temperature transmitters, tank level transmitters and liquid level switches.

Although instrumentation on the site was relatively new, periodic voltage spikes,

Fig. 1. Typical well diagram.

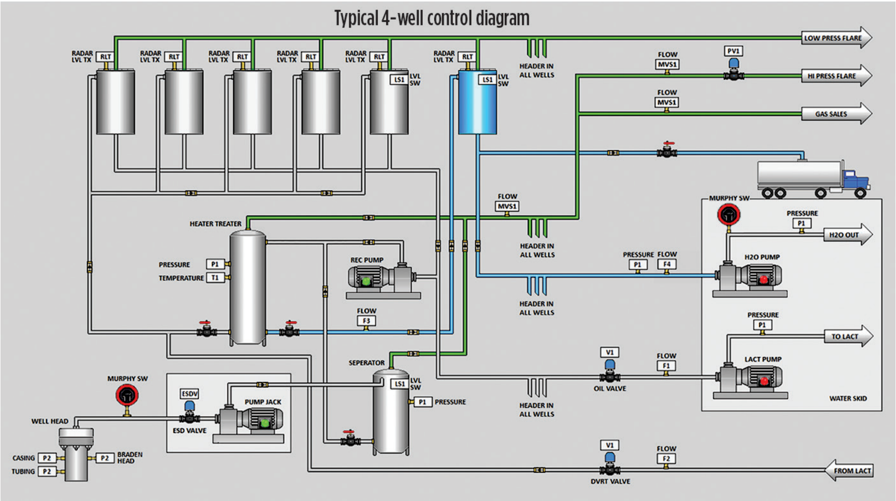

Table 1. Wireless labor/installation costs vs. wired.

	Wireless	Wired (includes cost of cable and conduit)
Tanks	$135.60	$24,500
Wellhead	$67.80	$4,000
Heater treater	$135.60	$32,000
Flare	$67.80	$9,000
Saltwater pump house	$67.80	$6,000

Table 2. Total savings from wireless I/O integration.

	Instrumentation	I/O	Installation	Total
Wireless cost difference (per unit)				
Flare	$1,407.00	n/a	($8,820.10)	($7,413.10)
Saltwater pump	$1,564.77	n/a	($5,820.10)	($4,255.33)
Per unit totals	$2,971.77		($14,640.20)	($11,668.43)
Per well wireless difference				
Tanks	$4,430.58	($2,100.00)	($23,870.00)	($21,539.42)
Wellhead	$2,453.40	($1,500.00)	($3,820.00)	($2,866.60)
Heater treater	$1,423.60	n/a	($31,820.00)	($30,396.40)
Per well totals	$8,307.58	($3,600.00)	($59,510.00)	($54,802.42)
			Total pad savings	($66,470.85)
			Example: Four-well pad savings	($230,878.11)

caused by grounding complications, were producing false readings on storage tanks. This would trip automated, high-tank-level shutdowns to protect against a spill, and force production to temporarily stop. Initial measures taken by WPX to prevent this included programming in high-level shutdown timers to minimize downtime. The problem persisted, however, and throughout the course of the year, system maintenance was frequent, and non-productive time was estimated at 1% to 10%.

TURNING TO WIRELESS

WPX had previously experimented with wireless tank transmitters (non-Emerson) on other wellsites in the Bakken, but the performance of their batteries in cold weather presented a number of problems. With sub-zero temperatures in the winter months at NJE, choosing transmitters that could operate in difficult conditions was critical. Having already had success with Emerson's wired transmitters in the past, WPX selected the firm as the primary provider of wireless instrumentation at the site.

In addition to substantially reducing the time and cost of installation, wireless transmitters were chosen to ensure that the grounding issues causing well shutdowns would not be a problem. With no need for trenching, pulling cable or running conduit, the environmental footprint of the project would be virtually non-existent. Implementing wireless I/O also would allow for the elimination of analog modules, which were used in hardwire control instrumentation loops utilized by programmable logic controllers (PLCs) and remote terminal units (RTUs) on the site.

While the primary objective of the pilot test was to evaluate the performance of wireless transmitters in the field, WPX conducted a cost analysis study to quantify any potential savings, which could be achieved by integrating wireless technology with future wells in the Williston basin. In addition to providing five battery-powered 3308 Guided Wave Radar (GWR) Level and Interface Transmitters for the pilot test, Emerson was selected as the sole provider of the wireless products that would be used in the cost study, including:

- Three 2160 vibrating fork, liquid level switches
- Four low-pressure transmitters with accompanying integral manifolds, two for each saltwater pump house and heater treater
- Three high-pressure transmitters with accompanying integral manifolds for the wellhead
- Two temperature transmitters
- Two thin-film platinum RTD sensors, each for the flare and heater treater

Wireless GWR level transmitters were installed in parallel with the site's hardwired transmitters, and data were collected so that performance could be evaluated, **Fig. 1.**

INSTALLATION SAVINGS

The pilot test at NJE showed that the greatest cost benefits of wireless I/O, when compared to hardwired systems, are realized during the installation process. With labor and material included (wire and conduit), the total cost to install the hardwired instrumentation at the site was approximately $75,000. On the other hand, the cost to install the wireless transmitters would have been less than $500, **Table 1.**

This disparity is due largely to the fact that wireless I/O doesn't require trenching, cable trays, junction boxes, running of conduit, performance of loop checks or burying of cable. Emerson instrumentation also took advantage of the WirelessHART standard, which requires minimal network design—forming itself and continuously optimizing paths by adapting to the topology of the field when conditions change. This made setting up the wireless infrastructure at NJE simple (no surveying was required), and it substantially reduced the time that an electrician needed to be onsite.

Installation of the five wireless GWR level transmitters on tanks took approximately 7 hr, whereas the installation of hardwired level transmitters required electricians to be onsite for several days and cost more than $24,000 (including the cost of cable and conduit). Start-up troubleshooting was virtually non-existent with preset configurations on wireless transmitters, as well (partially done remotely).

In addition, the cost study estimated that savings from installation, alone, would be $8,800 on the flare (one level switch, one temperature transmitter, one RTD sensor), and $5,800 on the saltwater pump house (two low-pressure transmitters and two manifolds). With the initial cost of the wireless transmitters included, which were more expensive than their wired counterparts, the total savings that would have been achieved at NJE, had all of the wireless instrumentation been installed instead of hardwired transmitters, were approximately $66,000. On a typical four-well pad in the Williston, WPX estimated that as much as $230,000 could be saved with wireless I/O integration, **Table 2.**

The cost analysis also revealed that going wireless would allow for the square footage of onsite control buildings to be reduced by as much as 33%. In addition to fewer wires and multi-cable transfer boxes, wireless eliminated the need for two $1,500 analog cards and one $600 discrete card, along with accompanying base and terminal blocks. This would result in smaller panels and more free building space. WPX estimated that redesigning onsite control centers with a smaller footprint could save as much as $18,000 in building and shipping costs.

IMPROVED RELIABILITY

The significant savings from the pilot test at NJE 28HC solidified wireless I/O as an inexpensive instrumentation option in the Williston basin, but drawbacks with existing hardwired instrumentation at the site made the reliability and performance of wireless transmitters a critical evaluation parameter, as well.

Emerson's Smart Wireless transmitters' use of WirelessHART created a self-organizing mesh network that allowed field devices to serve as alternate communication paths, so that signals didn't have to be sent directly to the gateway (base radio). This greatly improved the reliability of communications on the site, and allowed data to continue streaming from transmitters when signals were forced to be rerouted. In simple terms, the wireless network at NJE has the ability to "self-heal" in the event that a device is removed or conditions change.

The mesh network also used direct sequence spread spectrum (DSSS) technology and channel hopping, as well as time division multiple access (TDMA) to ensure latency-controlled communications between devices. This eliminated the need for frequency planning and made the network highly resistant to interference from external sources. Since their installation, the wireless transmitters at NJE have experienced 99.9% uptime. The very small amount of downtime is believed to be a result of the time that it takes for the mesh to reform after power is shut down for generator and/or site maintenance.

As is the case with any wireless device, battery performance was critical to the viability of wireless transmitters at the site. The combination of low power circuitry and direct switch technology on Emerson 3308 guided wave radars balanced power consumption with high signal strength. Power module tests conducted by WPX, in both the winter and summer months, correlated with Emerson's claim that their shortest predicted life would be 7+ years for one-minute level updates before needing a battery replacement.

PROACTIVE MAINTENANCE, NOT REACTIVE

The enhanced diagnostic capabilities offered by wireless I/O also helped to improve wellsite maintenance by allowing WPX to troubleshoot and adjust instruments remotely. With hardwired instrumentation, technicians had to be onsite physically to troubleshoot. With wireless instrumentation, however, they could dial in through the gateway to change tags and view radar plots from almost any location — even from a regional office 700 mi away. This improved site safety by reducing the need for technicians to work in difficult conditions. It also reduced the amount of time that personnel spent traveling between wellsites and control centers.

Direct switch technology on 3308 guided wave radar level transmitters also minimized signal loss and ensured a high signal-to-noise ratio for more robust level measurement. This prevented transmitters from underperforming, due to challenging tank conditions that often can cause unplanned outages on wellsites, such as excessive vapor condensation, changing fluid density, and high viscosity.

Another feature offered by Emerson's level transmitters hasn't yet been utilized at NJE. The check level response function, which calculates maximum level change between preset updates and allows for the update rate to be set according to certain process conditions. Signal quality metrics (SQM) also may be utilized in the future, to provide visibility into probe surface conditions. The same goes for PlantWeb digital architecture, which communicates device health to technicians and uses predictive intelligence to alert operators before problems occur or transmitters malfunction. PlantWeb also offers recommended actions for fixing problems, providing a significant advantage over hardwired transmitters at the site, which have virtually no diagnostic capabilities at all.

SO, WHY NOT WIRELESS?

The bottom line is that in 2015, smartphones shouldn't be the only wireless devices on a wellsite. Yet throughout most of the world's oilfields, they still are.

While the pilot test conducted by WPX in North Dakota revealed the advantages of leveraging wireless I/O in the Bakken—where the combination of rising labor rates and difficult working conditions has made hardwired systems uneconomical—producers in highly developed plays, such as the Permian and Eagle Ford, are also beginning to reap its benefits. And as "doing more with less" becomes a more prominent theme within the industry, the question that every operator should be asking isn't *why should we use wireless?*—it's *why shouldn't we?* **WO**

ZACH WERTENBERGER is a senior automation engineer at WPX Energy, working out of the Denver, Colo., office. He has primarily been supporting the Bakken for the past two years. Prior to WPX, Wertenberger was with El Paso/Kinder Morgan for three years, where he worked on automation projects for natural gas compressor stations. He holds a BS degree in engineering, with a mechanical specialty from the Colorado School of Mines.