Wireless Wellhead Automation

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Introduction

Whether it's a new production well or an existing well, deploying wireless automation equipment at these locations to monitor critical process variables can provide numerous benefits. Many companies are making better decisions through integrated planning using field, operational, and other significant data sources to increase ROI, drive higher productivity, and improve operational safety.

By implementing wireless technologies, permitting, trenching, and running conduit are eliminated from the cost equation. This significantly shortens the system's engineering design time and enables rapid deployment – typically less than a day – of a complete installation for collecting accurate and reliable data autonomously.

Having laid some groundwork for wireless automation in general, the focus here will be specifically on wellhead automation solutions that involve wireless monitoring and control applications – providing a number of options that best suit a range of applications.

The goal of wireless or hardwired automation technology is the same at the end of the day: collect critical data from one or multiple locations and to get it where it needs to go. In most cases, that will be to a PLC or an RTU. With cloud computing and networking on the rise, that data may soon be going to an IIoT gateway, but that's another topic altogether.

Before looking into specific wireless options, here are some main attributes of any wireless automation system to be aware of for deployment in oilfields.

1. **Power:** When we talk about wellhead automation, we are mostly dealing with the far edge section of a network that may have power limitations. Therefore, you can rely on battery-powered transmitters or low-power I/O devices that can be connected to an energy harvesting system like a recharging PV (Photo Voltaic) "solar-powered" system for standalone operation without needing to access grid power.
2. **Safety requirements:** Devices must be safe for oil and gas production locations, meaning they must carry at least Class I, Division 2 certification. Devices that are line-powered usually have a "CID2" rating whereas some self-contained and self-powered solutions carry a "CID1" certification to meet higher safety requirements.
3. **Radio Frequency**: In North America, 900 MHz and 2.4 GHz license-free ISM bands are available for use while some may choose to deploy a licensed radio spectrum solution. For this discussion, we will focus on what is most commonly used, which are the unlicensed RF bands. As a rule of thumb, when frequency is doubled, range is cut in half. Therefore, 900 MHz has better propagation characteristics than 2.4 GHz. However, in highly congested 900 MHz areas, 2.4 GHz may provide some much needed frequency diversity. For last-mile telemetry applications, either band will suffice.
4. **What data is going to be collected?** Operators must first evaluate their wellheads and what points require monitoring. Monitoring casing, tubing, and surface pressures are most common (analog). Arrivals sensor monitoring (discrete) and valve control application can also be added as part of the automation solution.

Wireless Options

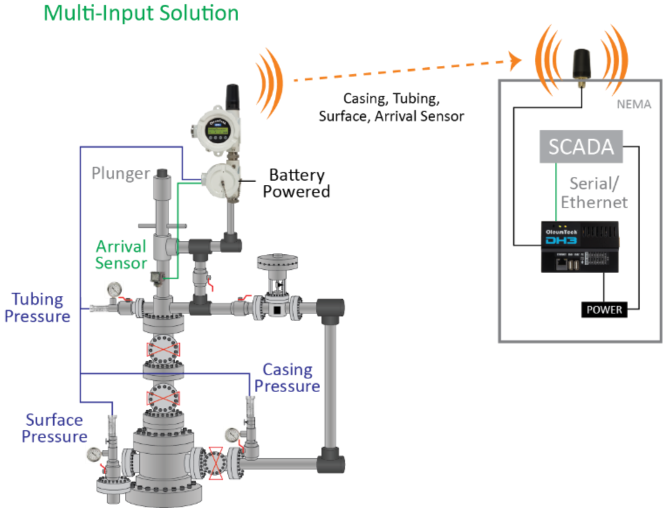
Option A: Self-Contained Transmitter (Sensor Network)

One of the most common methods for monitoring wellheads is using self-contained wireless transmitters. These are designed for rugged outdoor performance where they can be mounted directly onto a process. There are specific transmitters for monitoring pressure or discrete inputs, and some offer transmitters with multiple inputs, significantly lowering the equipment cost per point. Some are battery-powered and some are externally powered. A wireless sensor network, which these transmitters belong to, provides high scalability where additional nodes can be easily added for monitoring other processes such as level, temperature, flow, and on/off or opened/closed status. Some nodes also have the ability to execute output commands for control applications or to be utilized as a Modbus, LevelMaster, or HART master device expanding remote automation applications. This type of network connects to a SCADA system via common protocols such as Modbus or LevelMaster ASCII.

Monitoring capabilities (inputs): pressure (0-10 V, 4-20 mA), discrete (arrival sensor), level, temperature, flow, Modbus, HART, etc.
Control capabilities (outputs): discrete (valve/pump control, on/off)
Requirements: gateway with antenna and cable, battery or external power, COM port to tie into SCADA system, installation hardware
Strengths: easy to install, high scalability, high compatibility with third-party SCADA systems standard protocols, minimal maintenance, offer CID1 solutions
Weakness: programming may be required, higher learning curve, fixed or limited I/O count per device due to form factor, read cycle maybe set to a longer interval for conserving battery life or power
Ideal application: ideal for complete oilfield automation, suitable when external power is absent, easily connects many locations

1. Self-Contained, Battery-Powered Transmitter

Multi-Input Solution



2. Self-Contained, Externally-Powered Transmitter

Multi-I/O Solution

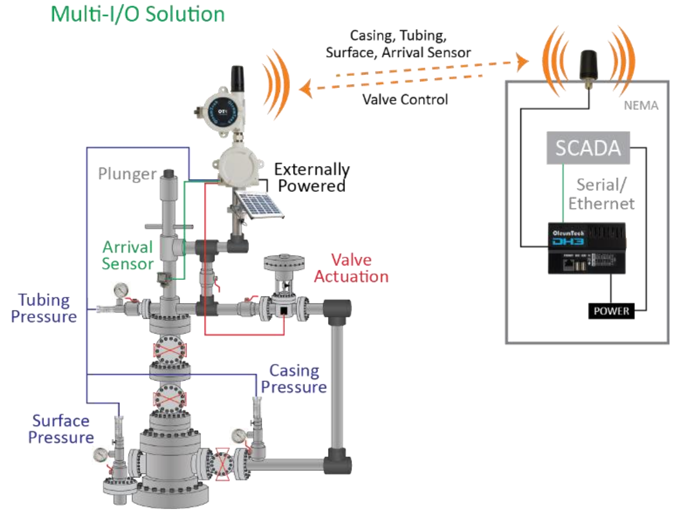


Photo exhibit 1. Fully scaled wellhead automation using solar-powered, self-contained transmitters.

Another common method for monitoring wellheads is using a multi-point I/O system. These are most suited when flexible, high I/O count is needed while providing high scalability. This type of network can connect to a SCADA system via common protocols such as Modbus or LevelMaster ASCII or using raw signals. Almost all multipoint systems require external power and additional hardware, which makes installation more challenging than deploying self-contained transmitters. On the upside, they may provide much longer RF range and faster data exchange rates than low power transmitters.

Monitoring capabilities (inputs): pressure (0-10 V, 4-20 mA), discrete (arrival sensor), temperature
Control capabilities (outputs): 0-10 V, 4-20 mA, discrete (valve choke, valve/pump control, on/off)
Requirements: antennas and cables, external power and enclosure, COM port to tie into SCADA system
Strengths: flexible and high I/O count, high scalability, longer RF range, faster data exchange rates (system always on)
Weakness: programming may be required, higher learning curve, installation setup
Ideal applications: setting up external power and enclosure is a non-factor, requiring high I/O count

3. Multi-Point I/O System

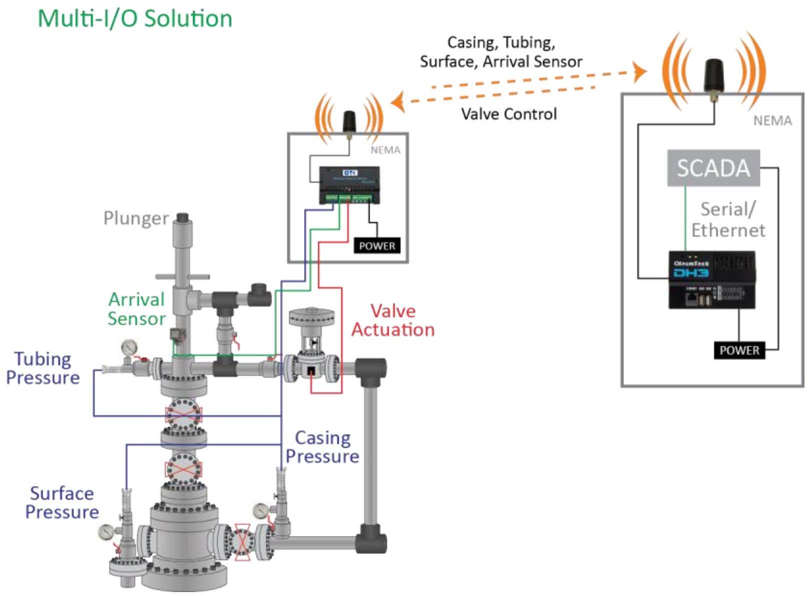


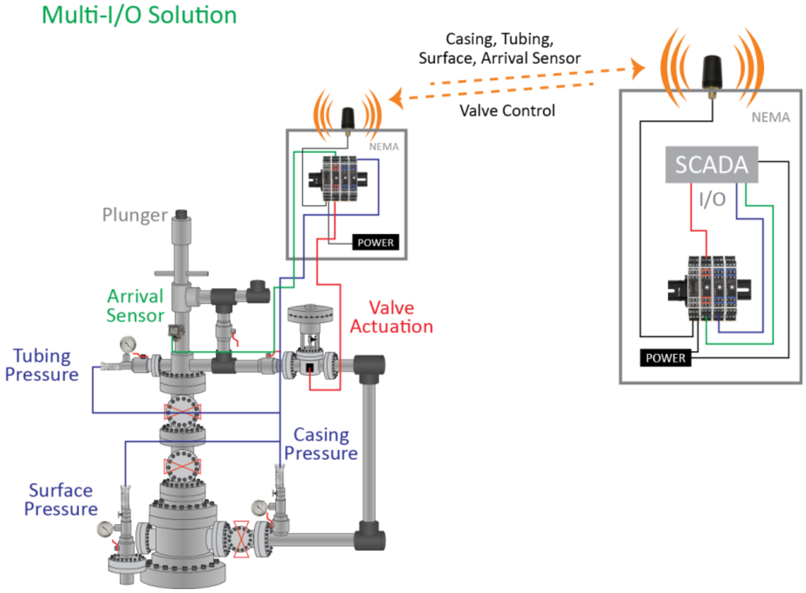
Photo exhibit 2. Wellhead connected to a multi-I/O system using external power and enclosure.

The simplest method of collecting field data is using a wireless point-to-point system that provides either uni-directional or bi-directional I/O communication. Think of it as a system that replicates hardwired signals from point A to point B with zero software programming. This type of system works well when scalability is a non-factor and also when the operator prefers or only has the option of using raw signals to tie into a SCADA system.

Monitoring capabilities (inputs): pressure (0-10 V, 4-20 mA), discrete (arrival sensor)
Control capabilities (outputs): 0-10 V, 4-20 mA, discrete (valve choke, valve/pump control, on/off)
Requirements: antennas and cables, external power and enclosure, available inputs and outputs to tie into SCADA system
Strengths: easy to use, low learning curve, no software programming, flexible, modular, high I/O count, longer RF range
Weakness: point-to-point does not allow scalability, cannot grow the network
Ideal application: connecting just one wellhead or stranded I/O points, point A to B only, communicating only raw signal data

4. Point-to-Point I/O System

Multi-I/O Solution



Summary

There are many benefits of automating an oilfield and this article focused on wellhead automation. When producers decide to look into wireless options for deployment, a proper system should be identified based on power requirements, safety rating, RF spectrum, and specific application requirements.

There are "one-trick pony" systems like a point-to-point wireless I/O system for quick deployment without a high learning curve or cost involved as long as the raw I/O signals can be wired into a SCADA system. Then, there are multi-point wireless I/O systems that better handle I/O distribution across multiple locations, providing high scalability and flexibility in communication using standard protocols or raw signals. There are also wireless sensor networks available that utilize self-contained transmitters that are either battery or externally powered, enabling rapid deployment. Sensor networks also allow additional nodes to be added for monitoring processes such as level, flow, temperature, and on/off status very easily and quickly, providing excellent flexibility and scalability.