Industrial Wireless: When Communications Must Absolutely, Positively Get There — In Milliseconds

Deterministic wireless networks for mission critical applications

Back in the early years of FedEx, its slogan was "when it absolutely, positively has to be there overnight" to emphasize reliable delivery. Today, the "absolutely, positively" part applies to the data packets of industrial wireless communications. But they must get to their destinations much, much faster — in milliseconds — to meet the mission-critical control and safety requirements of time-sensitive applications in industries such as oil and gas exploration, production and operation.

That's why they are called deterministic communications. And they are a far cry from the best-effort WiFi in homes, offices, cafés and just about everywhere in the world these days. Oil and gas operations can benefit from industrial wireless communication not only because of its deterministic nature and real-time reliability but also given its cost savings, flexibility and scalability compared to wired, fixed-cabled communications.

Ironically, field workers in many upstream and midstream environments readily use the onsite WiFi network on their laptops, tablets or smartphones as they would at home or in the office: to get and send email, connect to the Web, and even access company data and applications securely over a virtual private network. But because this is typically a standard WiFi network, connections still drop sometimes, giving them the impression that wireless isn't reliable enough for onsite industrial applications. Not true.

Why regular WiFi can't support industrial demands for fast, reliable communications

One of industry's earliest lessons in adopting WiFi technology years ago was that what works outside industrial environments like oil and gas falls far short of what's needed inside them. Home and office WiFi operates on best-effort transmission of data packets. That is, if some packets don't get through the first time because of collisions, they get re-sent, creating small, imperceptible delays.

Fortunately, latency doesn't matter in these situations because it all happens fast enough that users don't notice that their email got sent a second or two slower or the file they sent to the printer was similarly delayed. But, while WiFi networks in homes, offices and elsewhere are good enough for their users' demands, they cannot meet such industrial requirements as these:

- Deterministic communications. Oil and gas operations as well as automation and safety controls require fast, deterministic communications, so data packets reach their destinations within a predictable time span – inside the cycle time of a process's requirements. That's usually 100 ms or less.
- Rugged, fail-safe reliability. Industrial wireless also must meet much higher, more rigorous demands from their operating environments than home/office wireless. Obvious ones are harsh ambient conditions, like extreme temperatures – hot, cold and swings between each – as well as weather for hardware that must operate outdoors.
- Optimized RF engineering. Another consideration is the radio frequency (RF) environment. This can require careful engineering to address sources of RF interference, like cell phones and wireless handsets or even employee badge readers. Concrete walls and metal equipment, shelving and large inventories of metal stocks or finished goods, can either absorb or reflect RF signals. Motion control of

robotics and material handling also pose RF engineering challenges by causing intermittent shadowing and reflections.

How Siemens meets the exacting deterministic wireless demands of oil and gas applications

For years, Siemens has provided industrial customers with fast, reliable, and secure industrial wireless local area networks (IWLANs) via its SCALANCE line of communications products. Although IWLANs are significantly different from home/office WiFi in their reliability as discussed, they share a common architecture in having just two devices: wireless access points and client modules. The magic of IWLANs happens in how the two communicate with each other.

The latter are the small radio devices that reside on an application's machinery but are analogous to the laptops, tablets and smartphones with which home/office WiFi users connect to their networks. In fact, IWLANs using Siemens SCALANCE wireless equipment can employ an exclusive Siemens protocol called the iPCF (industrial Point Coordination Function) to ensure packet deliveries within milliseconds. Using the iPCF feature, applications with real-time demands such as PROFINET I/O are assured that each device can respond within its required cycle time on a I/O controller using PROFINET or any other industrial Ethernet protocol. Table 1 lists comparative cycle times for four typical automation scenarios:

Industrial Applications	Grace Time (seconds)
Non-Critical Automation	20
Automation Management	2
General Automation	0.2
Time-Critical Automation	0.020

Table 1. Comparative Automation Cycle Times

Siemens SCALANCE iPCF uses a unique polling method in which the access point cyclically queries each client module in its radio cell at very short intervals, and the transmission of any data that is not time-critical is postponed until free cycle time is available again. In effect, it assigns what might be called "talking rights."

This method ensures that the communication within a radio cell produces stable and predictable response times. These times are typically around 16 ms with five to eight clients, with intensive use of the available bandwidth capacity in the radio network. For this reason, iPCF is very suitable for production fieldbuses such as PROFINET, which achieve their real-time behavior through short cycle times.

Roaming. As anyone who's worked in oil and gas environments knows, they are not church halls. Pipe rackers are at work, drilling turntables are spinning, and trucks are coming and going. That's why the iPCF model of enabling deterministic communications that are fast and reliable can also handle roaming applications. For example, its predictability can ensure that even critical, safety-relevant data is transmitted reliably to the access point, even during roaming for time-critical applications such as emergency-stop decisions and controlling process times very precisely.

Data integrity. Another challenge in deploying wireless solutions in oil and gas is data corruption during transmission. Data corruption refers to errors that occur during writing, reading, storage, transmission, or processing, which introduce unintended changes to the original data source. This can occur, for

example, when a wireless client module, node, or terminal is visible from one wireless access point, but not from other nodes communicating with that access point. Figure 1 illustrates this situation.

The problem occurs when nodes A and C start to send packets simultaneously to the access point B. This causes collisions to occur within the network, thereby corrupting the data received by the access point and adding latency and consuming bandwidth.

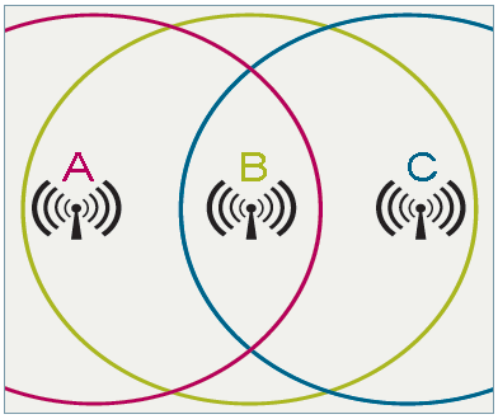

Figure1– The "hidden node" problem

By implementing iPCF which dynamically polls clients for data, end to end data integrity is assured by allowing cyclic and time-critical data traffic at predictable transfer rates. Additionally, iPCF also assures data integrity during roaming.

Safe, secure, reliable wireless for oil and gas applications to cut costs and boost flexibility

Siemens SCALANCE IWLANs using iPCF can be used for many different applications in the oil and gas industry. For example, safety applications can deploy the fail-safe SIMATIC Mobile Panel 277F along with a fail-safe SIMATIC PLC to achieve Safety Integrity Level (SIL) 3 protections, per EN 62061. It has IEC 61508 TÜV certification, facilitating compliance with the highest safety requirements according to the relevant standards: EN 954-1 to Category 4; EN 62061 to SIL 3; and EN ISO 13849-1 to PL e, the highest safety reliability.

Moving systems – walking rigs, frack trucks, cranes, pipe rackers and others – can take advantage of how the Siemens SCALANCE IWLAN iPCF feature solves roaming and end-to-end data integrity issues through prioritized, ultra-fast packet transmissions using its unique polling technique. In fact, with the use of IWLAN on site, the productivity of field workers can also be improved by providing uninterrupted real-time field data wirelessly for faster decision-making.

Oil and gas companies continue to be under extreme market pricing pressures to keep operating costs as low as possible to ensure profitability of their wells. At the same time, especially with fracking wells that can deplete in 18 months or less, asset utilization is critical to getting the most oil from the ground in the shortest possible time. Wireless communications from Siemens SCALANCE IWLAN portfolio can help reduce the costs of fixed-cable, wired networks, while also providing greater deployment flexibility and scalability for expansion.