



SIEMENS

Ingenuity for life

White Paper

How Rugged Wireless Technology can reduce costs in oil and gas production

to improve asset utilization and operator profitability

Summary

Wireless communications are well-suited for the oil and gas industry, especially given the often remote locations of production facilities, both on- and offshore. In the past, satellites provided producers with high-latency, low-bandwidth communications sufficient for transmitting telemetry data. But they fell short for system automation controls that required much less latency or for fixed and mobile multi-services like voice and video that require much more bandwidth. Fortunately, today's three terrestrial wireless technologies – WiMAX, WLAN and cellular networks – can meet those requirements with high levels of security. This paper describes these technologies and how the oil and gas industry can best deploy them to help reduce labor costs, while offering much greater operating visibility, control and efficiency – all of which can contribute to greater profitability.

Author

Mike Dalton

WiMAX Consultant
Siemens Industry, Inc.



Oil and gas production – ideal for wireless communications

Few industries in the world are as opportune for deploying today's advanced wireless communications as oil and gas production. With drilling operations and well-heads in some of our planet's most remote locations – and the latter mostly unmanned these days – producers need secure, cost-effective ways to monitor and control their operations from afar. This is especially true if they want another way to keep costs from rising faster than revenues.

Wireless communications have a wide range of applications for the oil and gas industry, both on- and offshore. Among them are:

- Multiservice alternatives to high-latency satellite communications
- Wireless connection of mobile applications
- Wellhead monitoring and control
- Gas field control and monitoring
- Rig power management and monitoring
- Rig internal communications
- Pipeline telemetry
- Data aggregation in rugged environments
- Process analytics

This paper aims to provide readers with an overview of the unique wireless requirements of the oil and gas industry and the three major categories of terrestrial wireless technologies that can be combined through good design and engineering for highly secure, reliable and cost-effective communications systems. These systems can help reduce labor costs substantially, while offering much greater operating visibility, control and efficiency – all of which can contribute to greater profitability.

Unique wireless requirements of the oil and gas industry

In fact, wireless communications are already connecting remote oil and gas production facilities around the world, while enabling greater operational visibility, control and efficiency. One offshore wireless network using Siemens RUGGEDCOM WIN wireless broadband technology spans thousands of square miles in the Gulf of Mexico and has operated since 2011.

With more than 120 base stations, the network provides multiple services, including SCADA telemetry, voice and video, not only from platforms-to-platforms and platforms-to-shore but also for approaching and departing supply vessels servicing those platforms. Compared to satellite communications, it does so with much more bandwidth and much less latency and cost.

Beyond remote connectivity. In deploying wireless technology, however, care must be taken to address the industry's special requirements that go beyond remote connectivity. Obviously in-home and office wireless network technologies fall far short of those needs, but so would most high-performance industrial wireless networks, too. Hazardous operating conditions and rugged environments, such as extreme temperatures, corrosive saltwater, constant vibration and penetrating dust and dirt, are just some examples.

Another big requirement is cyber security, given that oil and gas industry networks are by far the #1 target of industrial hackers, according to the U.S. Department of Homeland Security. Of the top 16 industrial sectors it has designated as critical to our national interests,¹ cyber attacks on energy in 2015 were 16% of all attacks deemed serious enough for its Industrial Control Systems Cyber Emergency Response Team (ICS-CERT) to investigate.²

¹ <http://www.dhs.gov/critical-infrastructure-sectors>

² ICS-CERT_Monitor_Nov-Dec2015.pdf, available at ics-cert.us-cert.gov

That was almost three times the number of attacks on government facilities.

Finally, remote and often unmanned facilities require that high-performance wireless communication infrastructures not only be rugged and secure, but also highly reliable – carrier-grade, that is – and simplified, to ease the engineering and maintenance burden on the producers’ enterprise IT and operating engineering teams.

Offshore wireless networks, for example, can cover thousands of square miles, especially at sea, as the previous Siemens deployment example in the Gulf of Mexico illustrates. Troubleshooting and replacing a failed component over such a wide area can be extremely expensive. Meanwhile, a communications breakdown can disrupt operations and, worse, imperil operational safety, with grave and costly potential consequences to human life and the environment.

Out of the sky: three categories of terrestrial wireless technologies

Before the past decade’s advancements of terrestrial wireless technologies made them practical for use in the oil and gas industry, geostationary satellite communications (also known as fixed satellite service, or FSS) was used mostly for remote SCADA telemetry. Then more bandwidth became available using VSAT (very small aperture terminal) technology like what satellite TV uses, providing wide-area coverage for maritime and land-based remote communications needs. Voice communications largely used ship-to-shore radio telephones operating on shortwave frequencies.

While FSS data rates, typically from 4 kbit/s to 4 Mbit/s, may be sufficient for SCADA telemetry and batch data feeds, they’re inadequate for real-time voice, video and control communications. The main reason is latency, which is a delay caused by simple physics: It takes about a half-second for a signal to make a round trip from Earth to a satellite more than 22,000 miles in the sky.

Another problem with FFS communications is heavy rains, which can block signals for the duration of a torrential downpour, as anyone with in-home satellite TV will attest.

Finally, there’s a cost issue. After setting up an FSS/VSAT infrastructure, operators must subscribe to ongoing service. To be sure, FSS price-performance has greatly improved in recent years, and new VSAT systems have come online using Ka band technology that promises higher data rates for lower costs. However, for the most cost-effective, real-time communication, terrestrial wireless technologies are the way to go.

WiMAX, WLAN and cellular networks. Since their respective debuts, these technologies have continued to steadily advance their capabilities, lower their component costs and simplify network engineering and management. The following table summarizes their bandwidth, reach and the international standards upon which the Siemens industrial communication is based.

Table 1. Feature comparisons of WiMAX, WLAN and cellular technologies according to the IEEE standards

Technology	WiMAX	WLAN (also known as Wireless LAN)	Cellular network ¹
Reach	3-25 miles (5-40 km)	Up to 0.6 mile (1 km)	50-85 miles (85-135 km)
Bandwidth	10-40 Mbit/s	450 Mbit/s	50-100 Mbit/s
Standard(s)	IEEE 802.16	IEEE 802.11	Several, with LTE and CDMA2000 dominant

¹ Depending on the carrier/provider coverage

Even when 4G/LTE is included in the following chart, please note that often 3G is available in remote areas where oil and gas deployments typically require wireless technologies.

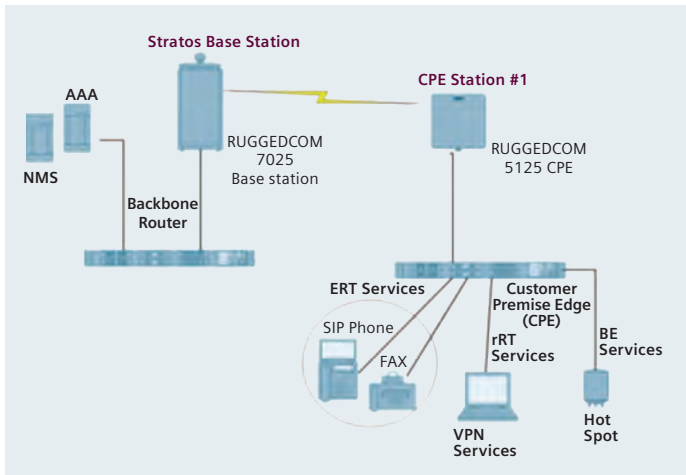
Note also that an inverse relation exists between bandwidth data rates and reach. In addition, longer distances require greater power for the components to generate signals strong enough to reach their destinations – which could be a receiver, to bring the signal to an end-user (or a monitoring control system) or a repeater, to relay the signal further.

WiMAX goes the distance



Because of its long reach, WiMAX is the technology of choice for interconnecting remote offshore drilling and well-head platforms and their onshore counterparts that may be dispersed over long distances. The Siemens RUGGEDCOM line of WiMAX products earned its name by setting the standard for mission-critical communications networks deployed in harsh environments for many industries worldwide. Among those are, electric utilities, transportation systems, automation, and defense networks.

Although the RUGGEDCOM product family comprises 14 hardware lines and two software solutions, the RUGGEDCOM WIN WiMAX 4G Broadband Private Radio base stations and subscriber units are the principal components for an advanced wireless solution based on the IEEE 802.16 WiMAX standard. Together these ultra-compact, solid-state devices can provide high-quality, multiservice wireless broadband communications – voice, video, and SCADA control and monitoring data – for fixed facilities. They can also do the same for delivering nomadic broadband communications to moving vehicles and vessels at sea, with latency rates as low as 20ms.



Global spectrum flexibility. These units can operate in nine unlicensed, licensed and so-called lightly licensed (3.65 GHz) frequency bands, for deployment flexibility all over the world. In North America, the 3.65 GHz band and unlicensed 5 GHz band are most often used because they are readily available via FCC rules and avoid radio interference with other devices and technologies, such as FCC-licensed microwave and WLAN and Bluetooth short-range radios that use the 2.4 GHz band.

In several countries and in offshore deployments, carrier-grade frequency bands can be used for WiMax deployments. Spectrum rules vary by country and should be researched for the particular geographic area as part of an initial system design process.

Extreme durability. Like all RUGGEDCOM gear, the base stations and subscriber units are not standardized models that have been “hardened” with added environmental protections. To be clear, they are designed and engineered from the start for ultra-reliable performance in a wide range of hazardous and extreme environmental conditions. In short, ruggedness is a core design that’s built-in and not added-on.

The RUGGEDCOM units comply with ANSI/NFPA Class I, Division 2 standards to prevent explosions, given their potential use in areas of flammable hydrocarbon gases, vapors or liquids. They can operate in extended temperature ranges from as high as 167°F (75°C) to as low as -40°F (-40°C) temperatures that fall well within the range of even equatorial extremes. Last, they are IEC IP67-rated against intrusion by dust and blasts of corrosive saltwater.

Enhanced security. With hackers targeting the energy sector far more than any other industry, several layers of “defense-in-depth” security are critically important, as recommended by all cyber security professionals. That’s why all wireless communications via RUGGEDCOM WIN WiMAX 4G base stations and subscriber units are encrypted via the 128-bit Advanced Encryption Standard (AES) standard adopted by the U.S. government and used worldwide.

In addition, these devices also comply with the Critical Infrastructure Protection (CIP) cyber security standards set forth by the North American Electric Reliability Corporation (NERC).

Next, they feature Remote Authentication Dial In User Service (RADIUS), a networking protocol that centralizes Authentication, Authorization, and Accounting (AAA) management for all users connecting with a RUGGEDCOM WiMAX network. The devices’ event-logging takes this authentication a step further by enabling forensic reviews of network access and use.

Network simplicity. Wireless networks used in the mostly remote, harsh operating conditions of the oil and gas industry not only need to be flexible, durable and secure, but they must also be extremely reliable. Although RUGGEDCOM’s centralized network management system can help troubleshoot and localize any component problems, sending a technician out to repair or replace parts can be extremely expensive, not to mention the disruptive potential of a communications system breakdown.

The key to this requirement is simplicity, via solid-state components (i.e., no moving parts to fail) and straightforward engineering. For example, base stations and subscriber units are engineered to eliminate the need for a \$250,000 Access Service Network (ASN) gateway and to use power-over-Ethernet (PoE), to simplify cabling. Also, each unit can operate in standalone mode, so scaling is simple – just add subscriber units, either as repeaters or receivers. With its Layer 2 feature set, the units effectively create a “CAT 5 network in the air.” Orthogonal Frequency-Division Multiple Access (OFDMA) helps provide reliable, multiservice connections, especially in spite of the radio-reflective properties of open water.

WLAN for the short haul



While WiMAX solutions with ranges up to 25 miles (40 km) are sometimes called “next-to-last-mile” deployment options, WLAN (wireless LAN) technologies are truly “last mile,” with transmission ranges of up to 0.6 (1 km). Another difference is WLAN’s much larger data rates of up to 450 Mbit/sec, almost 10 times that of WiMAX. This reflects the inverse correlation between distance and data rates.

The higher data rates can enable a wide variety of localized short-range oil and gas industry applications. WiMAX can interconnect with these applications to provide operators full, long-range visibility in real-time. Here are just a few examples from thousands of WLAN deployments among Siemens oil and gas customers worldwide:

- Slip-ring alternative for offshore platform-to-crane communications

- **Well-head monitoring and control, land-based or offshore**
- **Redundant wireless drilling rig communications in case a wired network cable breaks**
- **Secure, real-time communications between a land-rig driller controls cabin and E-houses (generator rooms, mud motor houses and shipping compartments)**

To enable these applications and many others for the oil and gas industry, the Siemens SCALANCE W product family offers different lines of industrial-grade WLAN products for a wide variety of requirements. Due to its industrial features (I-Features), the SCALANCE W products are also named as Industrial Wireless LAN (IWLAN) products. Most SCALANCE W devices can also be had with two software images, one to operate in standalone mode, the other to work in conjunction with an industrial WLAN controller. When using the controller-based version, you will find a central network intelligence called the SCALANCE WLC711 industrial WLAN controller at its core.

High performance. The SCALANCE IWLAN controller provides highly secure Layer 2 switching and Layer 3 routing for centralized management and QoS (Quality of Service) control of IWLAN networks comprising as many as 96 access points (APs) in redundant mode. Network administrators can prioritize data traffic, so time-sensitive packets (e.g., real-time voice, video or control) get through before best-effort packets (e.g., SCADA telemetry).

The IWLAN controller also automatically detects the new access points, establishes the connection with them and manages and coordinates access points and clients. In addition, it enables a clear error recording, monitoring of the radio network, and documentation of network statistics. All of this helps reduce commissioning overhead and operating costs, while improving operating visibility and control.

802.11n enables SCALANCE W700 client modules and W780 APs to use “smart antenna” technologies like MIMO (multiple-input and multiple-output), which uses multiple antennas at both the transmitter and receiver to boost data rates up to 450 Mbps. (Specialized tasks can also take advantage of SCALANCE RCoax cable, a WLAN radiating cable in lengths up to 525 feet (160 meters per Access Point in 5GHz) that can be routed alongside the traversing path of a mobile system, keeping in constant communications with any moving parts or vehicle.

Deployment flexibility, simplicity and scale. All SCALANCE W devices are compatible with IEEE 802.11 a/g/n standards, with the 802.11n standard being the latest and most powerful. Backward compatibility with 802.11 a/g standards helps preserve any legacy investments in those technologies. SCALANCE W devices offer built-in support both for 2.4 and 5 GHz spectrum bands and for PoE, to minimize cabling costs.

While using the controller-based versions, configuration management is done by the WLC711 industrial WLAN Controller. In case of the standalone products, the SCALANCE W products offer a unique solution for easy maintenance and device replacement. A thumbnail-sized, plug-in card called a C-PLUG enables automatic backup of network configuration

and project data in SCALANCE W modules and APs. A more comprehensive swap media card called a KEY-PLUG contains all the C-PLUG’s functionality, plus enables easy access to Siemens exclusive I-Features such as **iPCF (Industrial Point Coordination Function)**, **iREF (Industrial Range Extension Function)** and inter AP blocking. IPCF includes the deterministic algorithm needed for rapid roaming, deterministic real-time applications using PROFINET with latencies as low as 16 ms.

iREF is a Siemens unique I-Feature that enables a IWLAN network to cover a longer distance or larger area with just one AP by allowing its antennas to cover multiple areas with maximum transmit power, which reduces the number of channels and APs used.

These plug-in cards are exclusively for the stand-alone SCALANCE W700 access points and clients. They make commissioning new devices and replacing others fast and easy, without needing highly trained personnel as in the past. This feature simplifies deployments dramatically and can help oil and gas producers lower their overall operating costs even more.

Ruggedization. Like their RUGGEDCOM counterparts, SCALANCE W components are available with hardened options like IP65 protection against dust and water intrusion. Conformal coatings can provide additional protection from environmental elements, including UV light. In addition, units are engineered and tested to operate in extreme temperatures, from as high as 158°F (70°C) to as low as -40°F (-40°C). Finally, SCALANCE W permits the deployment of fail-safe applications and wireless fail-safe data transmission supporting implementations which demand SIL (safety integrity level).

Network security. As the centralized management element, the IWLAN controller also enables network administrators to put in place the same kind of layered, defense-in-depth strategy as the RUGGEDCOM family does.

First, administrators can use the controller’s Virtual Network Services (VNS) to group certain mobile users, devices and applications into VLANs (virtual local area networks) and give them their own service levels, access rights, encryption and device authorization. Each SCALANCE W access point can handle several VNS segments, which can offer even more deployment flexibility, in addition to what’s already been described.

Second, administrators can enable over-the-air, 128-bit packet encryption via WiFi-Protected Access (WPA), version 2, featuring the AES-CCMP protocol. Also, like its RUGGEDCOM complements, the SCALANCE W controller can be connected to a RADIUS/AAA server for centralized management of user authentication. All of this can – and should – be implemented within a greater system and enterprise cyber security program. These security features are available on the stand-alone devices as well.

[See the Siemens-Cimatic white paper “Security Measures Industrial Hackers Hope You Ignore” for an executive-level view of assessing and mitigating industrial network security risks.]

* * *

Cellular networks to fill the gaps

One of the big benefits of WiMAX and WLAN networks is their low operating costs. Aside from whatever cost accounting is done for their initial capital, engineering, installation and commissioning outlays, their ruggedized, solid-state components consume little power, need virtually no maintenance and rarely fail. With cellular wireless communications, much the same holds true except that, similar to satellite communications, an oil and gas operator must pay ongoing subscriber fees for access to cellular network services.

Nonetheless, sometimes cellular service is required to bridge gaps that neither WiMAX, WLAN nor a combination of the two can. The gaps may be the result of geography, especially line-of-sight topography issues, or because an oil and gas project's requirements may not cost-justify a longer-term WiMAX and/or WLAN wireless solution. One example would be setting up wireless communications for a mobile exploratory drilling rig.

Secured, cost-effective. In any case, the Siemens SCALANCE M family of cellular routers can provide a secured, cost-effective infrastructure needed to serve those types of requirements. They can communicate over public cellular networks with downlink data rates of up to 100 Mbit/s and uplink rates of 50 Mbit/s, depending on strength of the signal to the next cell tower.

Given the demanding operating conditions of the oil and gas industry, the SCALANCE M cellular routers are also engineered and tested to work in a wide temperature range, from as high as 167°F (60°C) to as low as -40°F (-20°C). With IP20 ratings, however, the devices will likely require enclosures rated NEMA 4 or higher.

Security from point-of-use to the cellular network is provided with an on-board firewall and VPN using the Internet Protocol Security (IPsec) protocol suite that authenticates and encrypts each IP packet in a communications session. The devices also use network address translation (NAT) to hide IP addressing from hackers.

Although unconventional extraction technologies have created a boom in today's oil and gas industry, especially in North America, maximizing asset utilization and profitability remain foremost imperatives for all operators – upstream, midstream and downstream. Industrial wireless technologies – specialized for the industry's demanding requirements – can help ensure greater utilization and profitability by providing more operating visibility, control and efficiency.

To help achieve these important objectives, Siemens WiMAX, WLAN and cellular network portfolios are backed by decades of engineering experience and expertise, proven through thousands of wireless deployments around the world. We invite readers to visit our website for more information or contact their local Siemens representative for a complimentary, no-obligation consultation.

<http://www.automation.siemens.com/mcms/automation/en/industrial-communications/iwlan-industrial-wireless-communication/Pages/Default.aspx>

Siemens Industry, Inc.
5300 Triangle Parkway
Norcross, GA 30092

For more information, please contact
our Customer Support Center.

Phone: 1-800-241-4453
E-mail: info.us@siemens.com

siemens.com/us-cyber-security

Order No. RCWP-RWTOG-0816
Printed in U.S.A.