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Wireless Solutions for Oil and Gas Industry

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Abstract

Wireless technology provides an exciting option for faster, more reliable communications. Wireless solution help oil and gas companies increase drilling uptime performance, improve in-field decision making processes and reduce operation costs by transforming isolated drilling sites to connected arms of the headquarter corporate work. Today, oil and gas companies have the opportunity to effectively break down the obstacles presented by traditional wire-line networking technologies. With wireless connectivity, networks can be quickly, easily and inexpensively modified to meet the company's changing needs.

Key words: *wireless, communications, oil, gas*

Introduction

Much of oil and natural gas production occurs in largely remote areas of the world beyond the economic range of traditional wired communications. Oil and gas companies must regularly collect critical data from remote well, offshore drilling platforms, outlying production locations and from SCADA (Supervisory Control And Data Acquisition) systems set up to monitor facilities, such as storage tanks, pumping stations or pipelines. Company personnel requires high-speed voice and fax services, email and web browsing. Establishing the required broadband network links between multiple locations using wire line links are not practical. The answer to this problem is the wireless broadband access infrastructure to ensure reliable site-to-site links, regardless of well or rig location, topography and weather-related considerations [1].

Wireless in Oil and Gas Industry

Oil and gas industry systems and networks may include, but are not limited to, process automation networks (PAN), distributed control systems, remote terminal units, programmable logic controllers and SCADA (Supervisory Control And Data Acquisition) systems [2]. Industrial wireless technology can apply to several process automation applications including:

- Oil/gas well heads automation
- Cathodic protection monitoring and control
- Energy management
- Vibration monitoring system
- Power monitoring system
- Remote surveillance and alerting solution

Requirements

Technology requirements for the oil and gas industry, in both upstream and downstream applications differ significantly from those found in traditional indoor office space. In the upstream operation of extraction and production, it is necessary to carefully manage and monitor the operations to prevent hazards such as oil spills and fires. In the downstream operations of pipelines, petrochemical plants, oil refineries and distribution channels, it is necessary to face the daily challenges to achieve great efficiencies with high safety standard.

Advantages

- Improve productivity

Wireless communications help to monitor the pipelines, tank farms and refineries efficiently and in real time. Wireless connectivity also eliminates the massive costs and deployment delay of traditional wired solutions.

Data and voice communication is required between the remote locations and head offices to report on work status, dispatch supplies and repairs, report on site-emergencies and transfer of geophysical data. Utilizing the network for internet access, email, voice-over IP and database access can improve the decision-making abilities of the company and the personnel in the field.[3], [4] This increase productivity and safety of workers in the field.

- Scalability of installation

Wireless networks can be quickly, easily and inexpensively modified or reconfigured to meet a company's changing needs. A broadband wireless infrastructure offers the flexibility to painlessly add or eliminate sites or to secure additional bandwidth by rearranging existing equipment or inserting additional nodes.

- Remote monitoring and SCADA

To monitor activity in a remote site is critical. Data from the well location such as wellhead measurements, gas pressures, flows, temperatures and leakage monitoring are sent via the wireless network. Remote monitoring and control also allows users to control remote facilities in response to changing system demands. There are lower production wells that must be closely monitored to obtain maximum production. Some well sites are many miles away from the closest monitoring facilities, making on-site data collection a costly and time-consumining operation. By utilizing remote site monitoring, the company is able to direct implicate in potential problem situation, reduce downtime and minimize costly repairs. Because they are no longer required to spend so much time on the road, field personnel are able to plan their schedules more efficiently [5].

Security and Safety

For oil and gas operations, security and safety are of the most importance.

Oil and gas companies work in a strategic and politically sensitive industry and face a number of treats ranging from terrorism, espionage, trough to potential disruption from activists. Today companies are striving to improve their security to protect critical infrastructure at the well site. Especially for the foreign production operations, it become the norm for the oil and gas industry to heavily protect its assets and personnel from the risk of sabotage or even terrorism by keeping a constant eye on production facilities, especially if these facilities are remote. Broadband wireless technology provide oil and gas companies with solutions for remote surveillance and security (Fig.1). A number of video surveillance cameras can be deployed quickly, easily and cost-effectively in a new or expanded security system. This system can now deliver high-

resolution, real-time video from remotely controlled security cameras to their central security office.

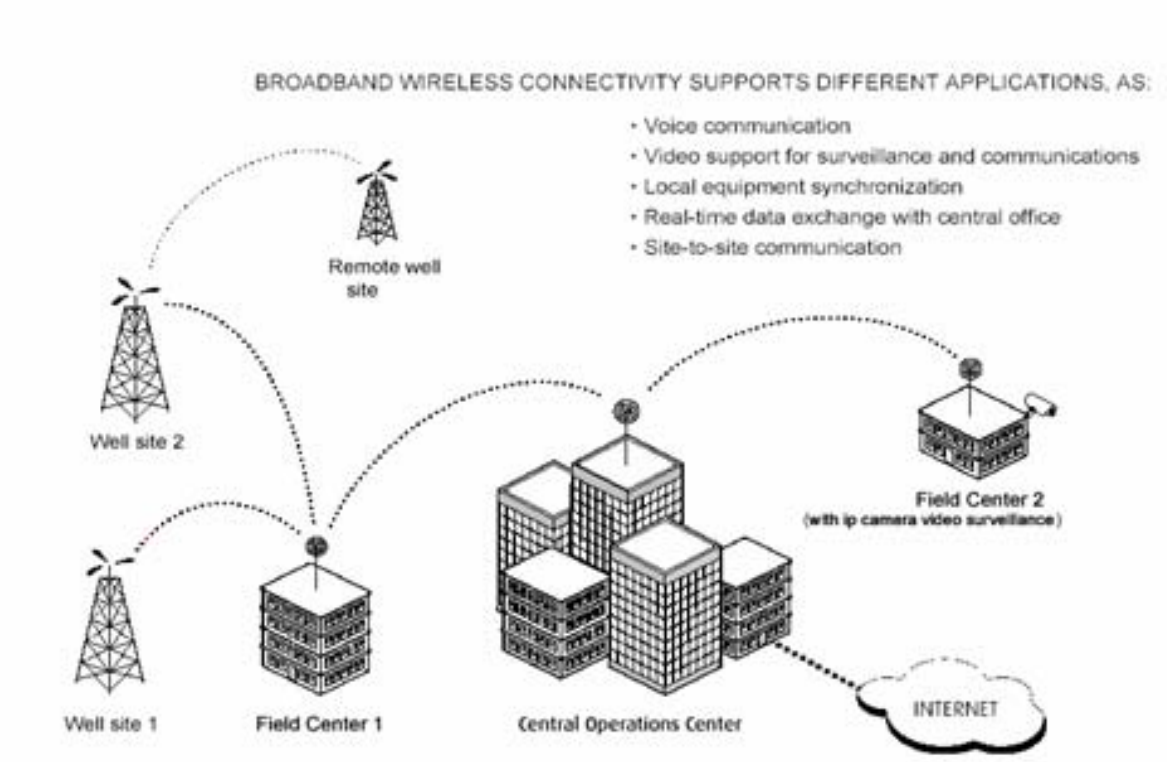

Fig.1. Wireless Network Configuration

Safety is another major consideration for oil and gas companies operating production facilities, as evidenced by considerable growth in budgets for oilrig safety. Real-time video surveillance transmission ensures that you can quickly deliver aid to an injured worker. Alarm systems and emergency well shutdown systems can now be deployed and managed remotely without crippling reliance on hard-wired communications infrastructure [5].

Wireless Surveillance Solutions in Oil and Gas Sector

The main challenge for a surveillance system is in monitoring such an extensive geographical area because different aspects of surveillance may be required in different areas.

Surveillance must consist of a video system fully integrated with other systems such as intruder detection and access control, with combinations of these systems deployed as necessary. Parts of the oil and gas installation may be geographically remote, but still need to have surveillance available to both local and central monitoring sites – the latter possibly being a considerable distance away. Thus a surveillance system must have networking capability over large distances and the flexibility to use different transmission media as required. Finally, one or more levels of redundancy must be built into the system so that surveillance is maintained in an emergency situation, when part of the system may have suffered damage.

Surveillance systems have to work cost-effectively across large distances, support remote monitoring, management and control, and 'scale' to cope with large numbers of cameras and sensors located in the harshest of natural environments. They also need to provide options for remote monitoring and control of dangerous sites in the event of an evacuation.

We can outline some of the available solutions to help overcome these issues.

For example, the latest IP video solutions can be used to put video on an IT network and offer cost-effective remote control and monitoring whilst providing the ability to centrally manage large numbers of sites and cameras. Organisations with thousands of sites, and tens of thousands of CCTV cameras, are now able to centrally manage and monitor their security systems. By providing flexibility of location, these solutions make it cost-effective to move video to security staff, rather than having to locate staff on each site. This also makes it simpler to ensure, and audit, compliance to health, safety and emergency procedures. The latest video management platforms also make it possible to integrate video with other information, such as alarm sensors and access control systems [6].

Before choosing and deploying a wireless surveillance system, the customer must first understand the issues facing his installation. These issues may be specific to his installation, or common throughout the industry. Non-technical objectives need to be decided upon. For example, a security audit is a sensible undertaking that would identify areas of high-risk or potential failure. For each type of risk or threat, the necessary combination of video surveillance and other security systems (such as intrusion detection) can be determined and then addressed in the design of the surveillance solution.

When choosing security systems, it is important to avoid the 'proprietary technology' trap and opt for open systems. A senior IT manager would expect to be able to replace one part of his system with systems from other vendors if necessary. This kind of choice and openness is now available from some, but not all, leading security suppliers. The choice of an open platform should ensure not only that 'best of breed' technology from different vendors can be mixed, but that information from different systems can be combined. As an example, when a smoke detection system raises an alarm it should be possible to immediately, and automatically, verify the alarm via video cameras whilst automatically logging system and staff response to the emergency.

The combination of security systems required will mean that the implementation of a multi-service network is crucial to allow all systems to work together. When considering which additional systems and equipment to utilize within the system, it is important to filter out 'technology hype' and evaluate the real practicality and suitability of other products and services

To meet the future surveillance needs of oil and gas companies, was developing new kind of cutting-edge technologies. The latest networked video solutions, provided by one of the leader in wireless communications, are focused on intelligence and automation.

The system is fully integrated with motion detection, video analysis (including license plate recognition) and access control, and can be set to operate in a manual or fully automatic mode. The latest codec is fully software configurable, allowing up to 112 video channels per unit to be individually configured as video encoders or decoders and with a choice of video compression algorithms. Furthermore, it is easily scalable with a choice of chassis sizes to suit every location, and has up to five levels of resilience and redundancy built in, providing an extremely robust solution to meet the industry's needs. In addition, the networked video recorder is ideally suited to large installations as it can simultaneously record up to 250 cameras. Its intelligent storage feature automatically archives video at reduced frame rate to optimize storage space and reduce bandwidth requirements, whilst still providing quality video.

The use of automated video content analysis can significantly enhance the monitoring of large perimeters and remote sites such as pipelines and pumping stations, and it is now possible to reliably detect people and vehicles in areas of risk. It was investing heavily to not only extend this technology to other applications, but also to reduce the cost of the systems and make them simpler to deploy. Wireless systems can greatly reduce the cost and complexity of deploying

video surveillance in harsh or remote environments, especially when protecting perimeters and pipelines [7].

Wireless Mesh Gas Detection for Oil and Gas Exploration

Workers operating in the oil and gas exploration industries are at risk for exposure to sour gas—gas containing H_2S (hydrogen sulfide) at potentially toxic levels. Operations located in densely populated areas pose additional threats of exposure to the general public. The danger can develop over time, even if the gas source was initially "sweet" (low in H2S). Local and national regulations define acceptable exposure levels for workers and the public. Over the years, industry has adopted low-level H2S detection, and continues to look for improved technology to ensure the safety of its workers and the community while meeting regulation requirements.

Safety managers need the ability to remotely view sensor readings in realtime to make quick safety decisions and to discard the threat. With technological advancements in wireless communication, more and more companies are looking to wide-area wireless gas detection systems to meet their detection needs, because these systems are much faster and cheaper to deploy than traditional wired solutions. They eliminate the need to transport heavy and expensive cables, plus they remove the need to dig trenches or install extensive wire networks.

Some aspects must be considered about the wireless gas detection methodes:

- conventional wireless gas detection methods used within the oil and gas industry, with highlights on their limitations associated with interference, complexity, and security.
- newer technologies available today, including the use of Mesh radios, which speed up deployment and provide stable communications.
- mesh wireless technology should be considered as the backbone for remote gas detection in oil and gas exploration and transportation.

Initial wireless gas detection systems deployed in the oil and gas industry utilized fixed-frequency narrowband transmission modems. Fig.2 illustrates what a traditional narrow-band signal might look like on an ordinary spectrum analyzer. These modems transmit gas concentration readings from one sensor to a controller.

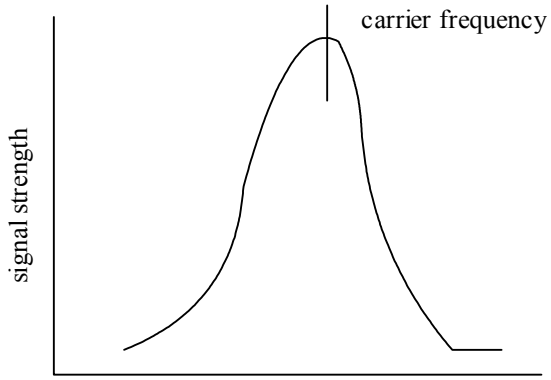

Fig.2. Narrowband fixed-frequency signal

Any obstacles between the sensor and controller cause signal loss. In addition, any "noise" from other wireless sources can easily interfere with the system's operation. This type of co-channel interference occurs when two modems broadcast on the same frequency. As more and more devices using these types of modems were deployed, interference issues became a bigger concern. Because reliable, uninterrupted data transfer from sensors to controllers cannot be

compromised, many companies have started to look for alternative wireless solutions that do not have these inherent limitations.

In order to accommodate multiple transmissions within the same frequency band, the narrowband signal can be spread out. The two most common methods for spreading the signal are frequency-hopping spread-spectrum (FHSS) and direct sequence spread-spectrum (DSSS). In an FHSS system, the transmission frequency is randomly varied with time. At any particular moment, the system essentially operates using narrowband transmission, but because the modems are continuously jumping to different frequencies (up to 1,600 times per second), co-channel interference issues are greatly reduced.

In a DSSS system, the signal is spread over several frequencies and transmitted at the same time. By injecting a spreading code into the data, the resultant narrowband signal is broadened. The additional bits are not random, but rather are configured in an exact sequence that allows multiple transmissions to reside in the same spectral band simultaneously. The ordering also provides a method of correcting for various errors that may crop up during the wireless transmission. Finally, the spreading of the signal results in increased security because the signal appears much like noise.

These types of signal-spreading technologies offer solutions for co-channel interference, but they do not address the issue of bypassing obstacles. In addition, the high operating power requirements of these modems limit their use for wireless gas detection within the oil and gas industry. The need exists to combine these capabilities with other technologies to make systems practical for applications such as air monitoring on an oil-drilling rig or onboard a petrochemical shipping vessel.

A better wireless solution is to use the mesh modems. Mesh modems have the ability to automatically route the wireless signal to other nearby modems allowing them to easily bypass obstacles and increase the transmission distance. They can run for long periods of time because they require very little power to operate. Mesh networks require minimal programming because the modems locate the best path back to a controller and connect automatically. Any loss of signal is detected, and the network will identify the best method to re-route the signal and heal itself (Fig.3).

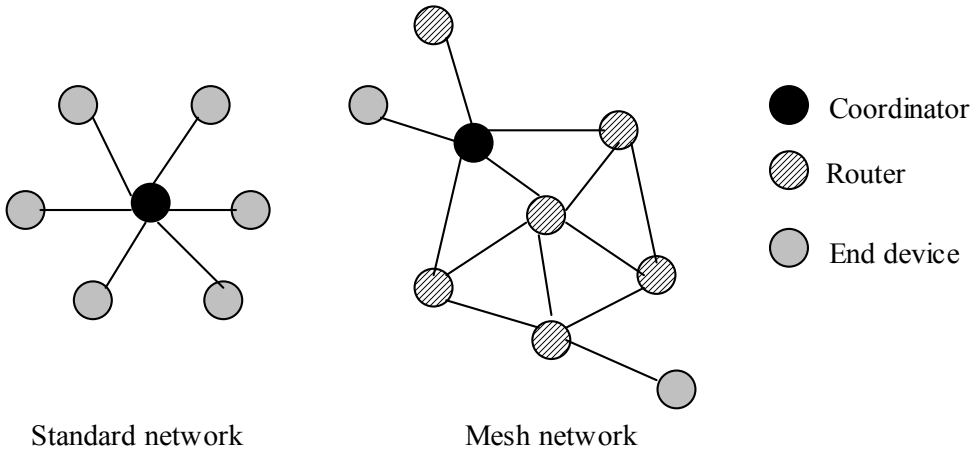

Fig.3. Standard and mesh network configuration

A mesh wireless network has many benefits:

- Reliability of wireless signal. Integrated routing function and self-healing of the network ensures delivery of data.

- Deployment time. Automatic network configuration means you are up and running in minutes.
- Cost. Acquisition costs represent a fraction of traditional wireless systems.
- Safety. Inherent redundancy of mesh system results in increased safety.
- Productivity. Reduced engineering design and system reconfiguration time [1],[8].

High Performance Wireless Mesh Network

A very reliable and performant mesh wireless network was deployed by Medco Energy company in the Karim Small Fields area in the Sultanate of Oman. The mesh network consists of wireless hops every seven to nine kilometers consisting of both point-to-point links and point-to-multipoint links. The MeshDynamics network cost-effectively delivers the real-time critical data that Medco requires to ensure operational efficiency. MeshDynamics MD4000 nodes operate in a wide variety of frequency ranges, but the 5.8GHz band was chosen for this installation as higher transmit power was permitted in that spectrum by the local regulatory authority.

The MeshDynamics patented and patent-pending technology links the drilling rigs with bandwidths of 36Mbps to 54Mbps. This enables seamless email and Internet connections and the exchange of drilling information between the rigs, the local office, and corporate headquarters, even over long distances and changing network topologies. MeshDynamics' QoS and network tuning features support a wide variety of applications while insuring that the most critical data always receives the highest priority.

The equipment must operate in a very demanding weather and physical environment, yet be easily transportable and quick to set-up. The MD4000 wireless mesh family supports up to four radios in a rugged weatherproof enclosure about the size of a hardbound novel, ideal for demanding application. Solar power systems were installed at a number of locations to power the mesh nodes [9], [10].

References

1. Nicolaescu Stefan-Victor - *Sisteme de acces radio de banda larga conforme standardelor IEEE 802.xx*, Bucuresti, 2006.
2. http://www.arubanetworks.com - *Secure Mobility Solutions for the Oil and Gas Industry*
3. http://www.sine.ni.com/cs/app/doc - *Oil and Gas Drilling Wireless Data Acquisition System*
4. http://wwwmotorola.com/governmentandenterprise/hk/en-sg/public/function - *Oil&Gas*
5. http://www.eonwireless.com - *Wireless solution for Oil and Gas*
6. http://www.well-surveillance.com/index.html - *Oil Rig, Well & Natural Gas Pipeline Camera & Webcam – Monitoring & Surveillance Wireless GPRS Camera*
7. http://www.ngoilgasmena.com/pastissue - *Intelligent surveillance solutions*
8. http://www.raesystems.com - *Wireless mesh gas detection for oil and gas exploration*
9. *** *High Performance Outdoor Wireless Links Oil Exploration Enterprise,* MeshDynamics, Inc, April, 2008
10. http://www.iqpc.com – *Electronic & Wireless Technology for Oil & Gas,* April-May, 2008

Soluții wireless în industria petrolului şi a gazelor

Rezumat

Tehnologia wireless este o opțiune interesantă pentru dezvoltarea unor sisteme de comunicații cât mai rapide şi fiabile. Pentru companiile din domeniul extracției şi prelucrării petrolului şi a gazelor, alegerea soluției wireless duce la creşterea performanțelor sistemelor de forare, îmbunătățeşte calitatea şi rapiditatea în luarea deciziilor pe teren şi reduce costurile aferente producției prin transformarea locațiilor izolate aflate la mare depărtare în centre conectate direct cu sediul central al companiei. În prezent, companiile din domeniul petrolului şi al gazelor au posibilitatea efectivă de a renunța la tradiționalele tehnologii cu rețele cablate. În tehnologia wireless, rețelele existente pot fi modificate rapid, uşor şi cu costuri reduse în funcție de nevoile companiei.