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First Mile Wireless and Beyond: Future Applications for Wireless in Oil and Gas

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Abstract

Oil field owners and operators face two primary issues in exploration and production (E&P); production levels and operating plant integrity. In particular operators of legacy assets do not have real time visibility to sense the current levels of production and respond with actions to reduce lost production or intervene before there is a lost of plant / well integrity. The deployment of these sense and respond capabilities have been limited by the remoteness of these assets and the economics of “First Mile” connectivity.

Recent advances in wireless technologies have now resolved this limitation, and operators are looking to extend the corporate connectivity experience into the first mile, creating sophisticated sense and respond capabilities that increase asset productivity while reducing costs and improving communication and worker collaboration. This paper will briefly review current state of wireless in the oil and gas industry and discuss the future applications enabled by first mile wireless. These include:

- Automated sensor networks for monitoring production control systems: Monitor temperature, pressure, flow, vibration and emissions which have potential environmental impact.
- Instant mobile communications for extreme & remote locations: Deliver true office communications experience to anywhere in the world, enabling exploration or other nomadic operations to connect and collaborate with global peers.
- Converged Health, Safety, and Environmental communications: enabling all responders to communicate across disparate radio networks, and phone systems in a unified conversation to accelerate and improve incident response.
- Asset and personnel tracking systems: leveraging presence / location aware services to transform the health and safety and performance of field / plant operations.
- Integrated physical security systems: provide increased camera coverage and authorized access to any camera stream from anywhere or any application, thus changing to a proactive intervention security strategy from a reactive phorensic strategy.
- Real-time video collaboration to the field: taking field and collaboration beyond voice and data, enabling workers in who are disparate from the problem share the experience and impart more accurate knowledge to resolve problems.
- Real-time vehicle fleet access, onshore and off-shore: connect with mobile vehicles and staff using the best possible network backbone, including satellite, 3G, GPRS, or WiFi enabling anytime, anywhere access to staff and systems on vehicles or vessels supporting field operations

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1. Why First Mile Wireless?

Oil field owners and operators face two primary issues in exploration and production (E&P); production levels and operating plant integrity. In particular operators of legacy assets do not have real time visibility to sense the current levels of production and respond with actions to reduce lost production or intervene before there is a lost of plant / well integrity.

Cisco First Mile Wireless resolves this limitation, enabling operators to transform their operations by creating the sense-and-respond capabilities that increase overall asset productivity, while reducing costs and improving communication and worker collaboration.

First Mile Wireless networks provide the platform to enhance operational visibility. This visibility takes many forms. For example, visibility enables technicians to gain access to the same resources in the field as they are used to in the office such as asset management and inventory control applications. Operations centres can continuously send and receive data to actually "see" what is happening in the field. The production control system can be extended to give deep insight into what is happening in the first mile in real time, not just once a day subject to manual data collection. Sensors on the equipment in the field can tell operators when it is likely to fail, not only when it has failed. Data from the field can be collected and transmitted to exploration and geoscience experts for analysis, without the need for the staff to travel to these remote locations. The first mile wireless network can support the acquisition of data from the wellhead (even down-hole), transmit that data to a central location for management and analysis, and then communicate a response back to the assets. As a result, operators can respond with actions that will reduce or eliminate well downtime or increase hydrocarbon production.

In addition to providing visibility, First Mile Wireless networks can address the issue of scarcity of expertise at the point of activity, such as the oil and gas fields. By extending the office connectivity to the field and bringing operational visibility back to central locations, companies can make the most efficient use of experts, enabling them to manage multiple well operations and communicate with staff in the field in real time, and reducing operational costs.

The First Mile Wireless solution also provides security. Most oil fields are not occupied / patrolled locally, so there is a need to maintain the physical security and alert authorities to compromises and potential dangers. In the case of offshore drilling and exploration platforms, although personnel reside on the rig, security can still provide significant insight into hazardous working practices.

2. Challenges in the First Mile

The Cisco First Mile Wireless solution provides information to increase well productivity and operating efficiency by cost-effectively providing secure and wireless connectivity to the First Mile of the hydrocarbon value chain. But there are many challenges to delivering these benefits. The conditions that exist in the first mile are some of the most extreme in any industry (see Fig 1).

Fig. 1:

Challenges deploying technology in the first mile

Any solution must be designed to withstand the harsh and remote deployment conditions, including the following:

- Remote locations require various **cost-effective options for backhaul**. The high backhaul cost of very small aperture terminal (VSAT) and cellular links can be mitigated through use of wireless mesh, bridging, or WiMAX technologies. VSAT incurs a monthly service fee, while the other technologies involve only capital expenses and in-house maintenance.
- **Extreme environments**, which may contain hazardous / corrosive materials or explosive hydrocarbons, require wireless / infrastructure products designed to the highest standards, tested to operate over length periods of time and certified to be compliant with prevalent regulations.
- When there is **no existing infrastructure** in remote locations, owner / operators need ruggedized and fail-safe (redundant) solution architectures. Redundant designs for failover is highly recommended to ensure service levels are delivered.
- **Limited local skills** require zero-touch configuration and self correcting systems. Easy network manageability and high reliability are crucial.
- **High metal density** in deployment areas requires additional pre- and post-deployment site surveys, testing, and validation of Radio Frequency devices to ensure optimum performance.
- Infrastructure / Data Security with the highest standards is particularly important, given the **sensitivity and national security considerations** for oil / gas field information.

But why is it compelling to overcome these challenges? It is because there are many business case benefits to be realised, even from the basic solutions.

3. Access Opportunities From First Mile Wireless

First and foremost, First Mile Wireless provides access to corporate (Enterprise Resource Planning – ERP) applications for the mobile worker, replacing the traditional clipboard with a connected multi-function hand held device, e.g. PC or PDA.

Consider the maintenance worker with his / her work orders on a clipboard; a crew is issued with approved work orders by the maintenance planners on paper, attaches these to the clipboard, goes out to do the work, may or may not complete it, may not have parts on hand, may run into unknown issues, may not find the equipment that needs maintenance, etc…… the crew comes back at end of day and drops the updated paperwork into maintenance planner's inbox (at best !). The maintenance planner can then only update the Computerised Maintenance Management System (CMMS) with the information he / she has available from the paperwork. In the likely event that the paperwork is inaccurate / incomplete, the corporate record of the status of the work and the asset under maintenance is now misleading, inaccurate and should ot be the basis of future maintenance decisions.

Leveraging the wireless access, the clipboard is replaced by a handheld device. Now the work orders are preloaded, so no time is wasted picking up paper orders. A location based system will alert the maintenance technician when he / she is close to the piece of equipment referenced by the work order. Work instructions can be fed to the technician directly, along with any diagrams etc. If he / she sees an issue he can video the problem and send it in for analysis and assistance. If he / she runs into something about which he lacks experience, he can contact experts in the company directly while on the job because his handheld will give him access to the corporate directory. When the work order is completed, he signs off the work, the work order is updated and corporate information can receive the appropriate update. Necessary spare parts can be requisitioned while on the job, saving further time. All of these business process changes are enabled by the platform of connectivity of First Mile Wireless.

Beyond the immediate benefits that a mobile maintenance worker can leverage, there are many client devices types that could be connected, each providing their own benefits. These include:

- **S**upervisor **C**ontrol **A**nd **D**ata **A**cquisition **or SCADA Controls**: Production control networks are moving towards IP, but running new data cables required for this task is often not practical or economical in an oil or gas field.
- **Remote Monitoring Sensors**: low power wireless sensors for pressure, temperature, flow, vibration, and others use an emerging standard for communicating between each other. Theses sensors must have a secondary communications layer to connect to the control and analysis systems in central offices.
- **Vehicle Access**: Many systems on service vehicles (fracturing, logging, seismic, maintenance) would benefit from connectivity back to the corporate office. Combining GPRS/3G for on-the-road coverage with the high-speed WiFi coverage in the field would create a system where mobile workers and systems always had connectivity to the data and applications they need.

All of theses systems require the fabric of wireless coverage to deliver the full benefits. With the network as a platform, a broad array of WiFi devices can enable process transformation across the first mile.

4. Delivering First Mile Wireless

The Cisco First Mile Wireless solution consists of two main architectural components: a wireless fabric made up of layers of wireless technology, and a set of sense-and-respond business transformation capabilities to leverage the connectivity.

Figure 2, below, describes the architecture used to connect onshore fields with First Mile Wireless. Similar architecture is used in offshore installations.

Wireless connectivity is built up through three layers and consolidated network management. The components of the solution include:

- **Client**: Wired and wireless devices that take advantage of the connectivity in the field. These include low-power wireless sensors for environmental / equipment status, and PDAs or PCs for field service personnel.
- **Access**: Cisco Aironet® access points provide local access to these clients, arrayed in either a point-to-point or mesh configuration that can cover the entire area of the oilfield with wireless network connectivity. Cisco Aironet access points are ruggedized devices designed to operate in hazardous / certified conditions common to oilfields.
- **Mobile network**: Operators in the first mile can stay connected with all central applications and data, in and around their vehicles and while driving with the Cisco 3200 Series Wireless and Mobile Router installed in the trunk of the service truck or vessel.
- **Backhaul**: Connecting the access points to the corporate networks through long-distance, high-speed wireless links. These high-speed links can be a combination of bridging Wi-Fi or WiMAX links, VSAT, or a wired connection using DSL or fiber.

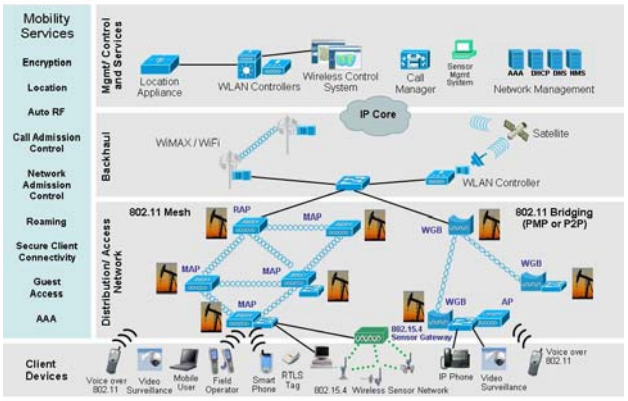

Fig 2.

Connecting onshore with Cisco First Mile Wireless

- **Control**: Wireless connectivity is controlled and managed through resources in the corporate network, including wireless controllers, the Cisco Wireless Control System, and additional Cisco security products like intrusion detection and VLAN management.
- **Sense-and-respond capabilities**: The capability to monitor and manage all operational activities in real-time or near real time, depending on deployment strategy.

5. Business Benefits from First Mile Wireless

A 2003 study by Cambridge Energy Research Association (CERA) found that digital oilfields increase production by 2 to 10 percent over their non-digital counterparts. The study also found that digital oilfields save US$4 to 8 billion in annual operational costs. A first step to establishing a digital oilfield is to provide economic, integrated, high-speed connectivity with the First Mile Wireless solution as key enabler towards a complete digital oilfield of the future (DOFF). The industry is recognizing that maintaining recovery rates and reducing extraction cost will require a move towards real-time systems—that is, real-time decisions made with real-time information.

Deploying the DOFF with IP-based technologies in remote field sites enables central operations to:

- Sense the current production situation with more precision and respond more quickly to problems, reducing equipment failure and increasing volumes.
- Enhance recovery through better data and production planning.
- Optimize work processes, maintenance, and operations to reduce production downtime and lower production cost.

The benefits and drivers for the DOFF will be initially realized in the First Mile with networking solutions that can be implemented in this harsh and remote environment. Based on IP standards, these deployments can be easily expanded, enhanced, and upgraded at a later point of time to accomplish the vision of the DOFF while keeping cost of ownership low.

An example of these benefits comes from Petrobel, a drilling operator for ENI in Egypt, They have implemented first mile wireless to enable voice communications throughout their drilling platforms, including from the drilling floor. This allows real-time collaboration between the drill supervisor and his peers and scientists onshore, without pausing the operations. In addition to an improved quality of decision making, they expect that reduction in drill stoppage will avoid more than $9,000,000 US dollars each year.

6. Future Applications: The Network as a Platform for Oilfield Operations

Organizations receive immediate benefits from the improved access to systems and communications, which provide a compelling case for first mile wireless. But it doesn't come close to stopping there. Beyond that in the first mile, there are many processes that can be transformed by leveraging this network as a platform and adding additional capability. And the lessons that are learned in the first mile can be used in other segments (midstream, pipelines, refining petrochemical manufacturing, etc) of the value chain. See Fig 3.

Beyond the basic access for your mobile workers and other wireless clients described above, there are additional services that can be delivered over this platform, which include:

- **Contractor Access**: Given that oil field service contractors would benefit from connectivity to their systems as well, using First Mile Wireless, you can provide "Hot Spot" access for contractors, complete with automated accounting where necessary.
- **Voice and video over wireless**: Providing real-time, rich media collaboration between field and central personnel (or field to field) is a key win. Situations requiring intervention can be better described using pictures and video, which can greatly enhance decision making. In addition, if enough voice and video capability are provided, you can reduce the number of personnel required in the field, improving costs and safety.

Fig 3:

Beyond First Mile Wireless:

In the field and throughout the value chain

- **Physical Security**: most assets in the first mile are unmanned, and providing a full-time visibility and protection is not cost effective. However, by providing wireless access for physical security systems improves flexibility of designs, simplifies installation, and improves the safety of assets and people. It can also improve incident response by delivering a real-time video stream of the incident directly to the responder. Video can be tagged and stored, to be retrieved and analyzed during investigations or interpreted by video analytics applications to intervene before an event occurs.
- **Asset and Personnel Tracking**—While the accuracy of 802.11a/bg/g based location services (typically a 5-6 meter sphere) limits its application in health and safety, there is still a great deal of benefit that can be offered through the delivery of "presence services". That is, knowing that consumables, assets, or personnel are present in a particular zone of the first mile can be leveraged into reducing maintenance and inventory costs, improve operations safety, and reduce losses.

- **Converged Health/Safety Communications**—enabling all responders to communicate across disparate radio networks and phone systems, such as VHF, UHF, GSM, TDM, and VoIP, in a unified conversation to accelerate and improve incident response
- **Environmental Monitoring**—Through data from low-power mesh sensors (gas, moisture, temperature, pressure, vibration) sent over the first mile wireless platform, an accurate view of the environmental situation can be created. This can be integrated through common policy engine that triggers alerts that activate the converged safety communications when incidents are detected
- **Logistics management**—Providing connectivity on supply vessels can close a traditional gap in maintenance and operations, creating complete visibility to supplies, personnel, and maintenance, improving inventory costs and other aspects of maintenance and operations
- **Instant mobile communications** for extreme remote locations and mobile command centers. Deliver true office communication experience to anywhere in the world, enabling exploration or other nomadic oil field operations to connect and collaborate with global peers

The first mile contains virtually all of the challenges that the other aspects of the hydrocarbon value chain have. By solving connectivity in the first mile, all of these lessons can be extended into the other aspects of an integrated oil company.

7. For More Information

For more information on the Cisco's First Mile wireless, you can review these websites.

Cisco First Mile Wireless solutions

http://www.cisco.com/web/strategy/energy/fmw.html

Cisco Outdoor Wireless Network solutions

http://www.cisco.com/go/outdoorwireless

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