THE INTELLIGENT DIGITAL OILFIELD

redline®
communications

POWERFUL. VERSATILE. RELIABLE.

EXECUTIVE SUMMARY / ABSTRACT

In the last few years, oil companies around the world have made dramatic advances to the way in which they operate their oilfields. Today's oil operations are safer, more collaborative, and much more productive than ever before. The processes and technologies that have allowed these improvements are centered on better workflows and efficiencies. More data from more areas of the operation is coupled with advanced analytics to provide an increased understanding of the physics and activities of the oilfield. The different trends that have always made the upstream an exciting theater of technology still come and go, but the main focus remains on advancements in workflows that provide long-life benefits and OPEX-driven savings.

To meet the increasing and challenging demands of safety, collaboration, and enhanced oil recovery, Oil & Gas companies require a reliable and versatile network infrastructure that offers high performance and security, and supports multiple end devices which are often moved to different locations around the field. Each element of this network must operate with mission critical reliability and in extreme environmental conditions while supporting a multitude of business applications simultaneously.

The result is an Intelligent Digital Oilfield that has a high-performance IP-core network with a high-capacity, low-latency wireless transport which operates across a large range, in extreme climates, provides non-line of sight functionality and is interoperable with devices from many vendors.

BACKGROUND

Increasingly, Oil & Gas companies are installing ubiquitous, high-performance IP networks in their oilfields around the world, connecting people and machines. They are motivated by the need to improve collaboration, increase visibility, reduce the need for on-site staff, and support Enhanced Oil Recovery (EOR) techniques. The vision for oil and gas IT departments falls into three categories:

- First is to extend the applications in the glass house environment out to the field. This includes all office software applications used daily as well as voice, texting, conferencing, and other collaboration tools.

- Second, they want to bring visibility of the field operations into the office. This is generally centered on a Process and Control network consisting of thousands of sensors managed and manipulated through various machine-to-machine (M2M) protocols. Process and control can be further enhanced by seismic analysis and subsurface modeling whereby a three dimensional image of the subsurface allows geologists to understand where oil reserves are located and how they are flowing during the extraction process. Seismic analysis can also allow drilling teams to use new "Smart-Drilling" techniques in order to bring wells online faster and safer. Field visibility also involves video surveillance which can greatly increase operational efficiency, assist in maintenance projects, and enhance strategies for improving HSE (Health, Safety, and Environment).

- The third category for communications requirements involves Enhanced Oil Recovery (EOR) techniques. EOR techniques, which include cyclic steam simulation, steam flooding, in situ combustion, polymer flooding and fracking, now allow oil companies to extract Heavy Oil and deep gas deposits cost effectively. The American Petroleum Institute and the International Energy Alliance both estimate that 40% of all existing oil reserves in the world are Heavy and Extra Heavy Oil, which must be extracted using EOR techniques. Every oil & gas company in operation will eventually require EOR technology in order to revive mature oilfields. To control, manage and monitor these difficult new EOR techniques, a high-performance IP network is absolutely necessary.

These three compelling network concepts are driving every major oil company in the world to install a multiservice high-performance IP network in their oilfields. But connecting all these devices is not simple.

Most oilfields cover thousands of square kilometers in remote regions with varying types of terrain and environments – from hot, dry desert sands to cold, arctic mountains to deep water, ocean operations. Running wires or fiber optic cable to hundreds or thousands of oil wells is simply not practical.

Additionally, much of the drilling and well equipment is moveable, so connecting them by fiber is not only impractical, it is impossible. The only choice for an intelligent digital oilfield is to blanket the entire operation with a wireless network.

Data Network

There are three main groups to the data network that provide information, safety and control to an Oil & Gas operation:

- The core network
- The transport network
- The edge network

Core Network

The core network sometimes called the central network, usually link directly with the regional headquarters for the operation; it consists of routers and gateways. The core network, transport network and the edge network supports reliable, timely and transparent delivery of data to and from end devices from different manufacturers that use different protocols which were released over an extended period of time. The entire network must also connect to and support specific servers at the headquarters or field offices that are interoperable with the different end device technology.
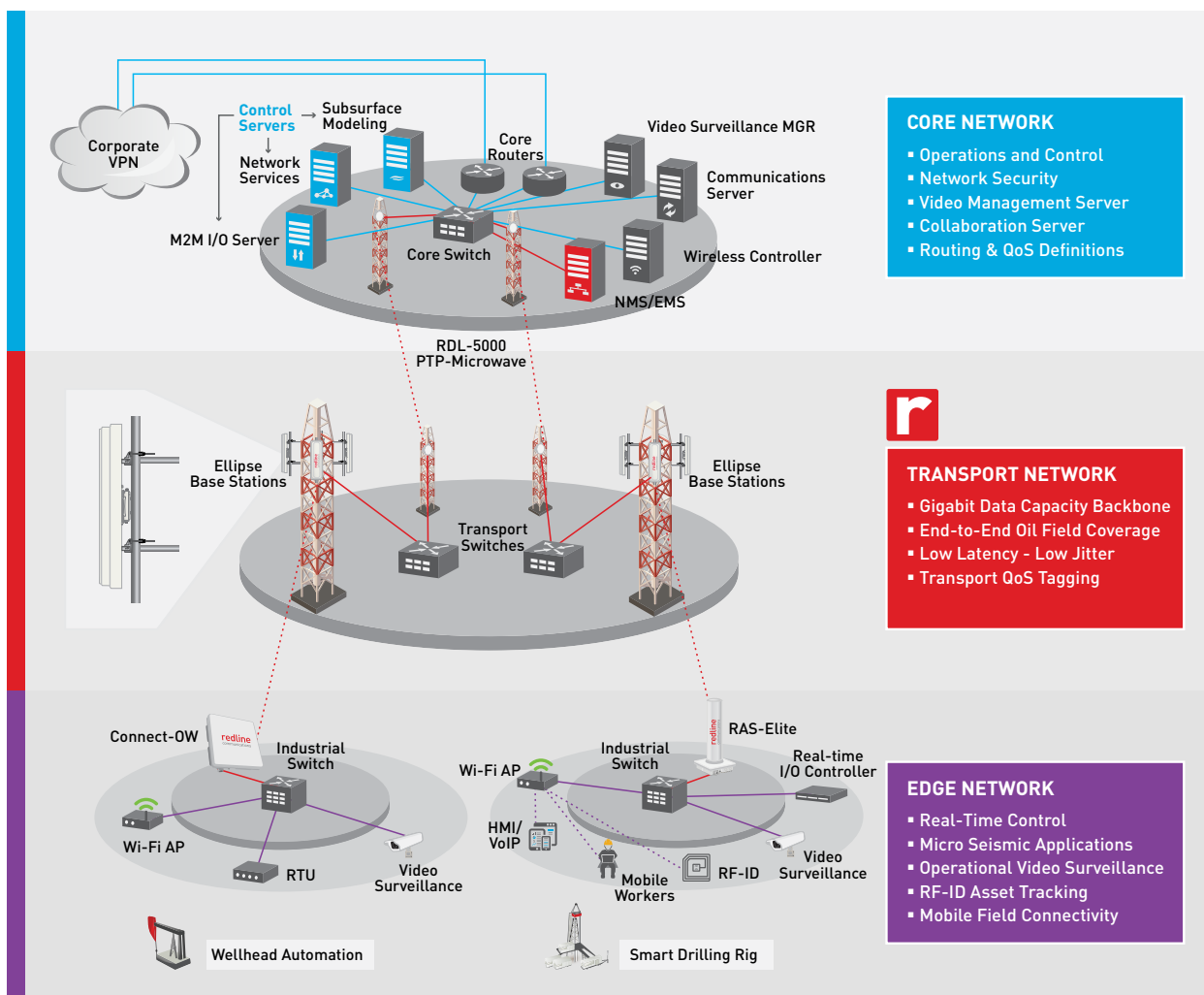
Transport Network

The transport network is the bridge between the core network and the edge network. Its function is to allow reliable and secure IP connectivity from each end device to the server that monitors/controls it in the core. Connecting the transport network with fiber optic cable provides high data capacity, low packet latency, and allows the network to support any technology that could be installed in the core or edge network. However, as mentioned above, fiber optic typically is not a viable solution for the transport network. For this reason, wireless connectivity is the medium of choice for the oilfield.

Traditional wireless transport solutions have some serious limitations. The few wireless technologies that offer fiber-optic data performance are very expensive, only support point-to-point connections, and have a short range. Supplying the transport network has always been the missing part of the digital oilfield. With Redline, oil & gas companies can finally deploy the intelligent oilfield that they have envisioned.

Edge Network

The edge network sometimes called the access network, connects all end devices and applications at the network edge, including the actual machines, sensors and computers that are used in the field operation. This includes SCADA and DCS devices, operational video surveillance and Wi-Fi for mobile field connectivity, to

support BYOD, PDAs, laptops, VoIP phones, and RF-ID for asset control.

CORE NETWORK
- Operations and Control
- Network Security
- Video Management Server
- Collaboration Server
- Routing & QoS Definitions

TRANSPORT NETWORK
- Gigabit Data Capacity Backbone
- End-to-End Oil Field Coverage
- Low Latency - Low Jitter
- Transport QoS Tagging

EDGE NETWORK
- Real-Time Control
- Micro Seismic Applications
- Operational Video Surveillance
- RF-ID Asset Tracking
- Mobile Field Connectivity

THE INTELLIGENT DIGITAL OILFIELD

An Intelligent Digital Oilfield requires an underlying communications network that seamlessly provide the right data at the right time – the "to" in machine to machine communications (M2M). The Intelligent Digital Oilfield is based on a robust IP Core, using Redline's Virtual Fiber™ to create a wireless backbone to connect the core network to a variety of end devices at the network edge. It has been proven to work with devices from a myriad of manufacturers representing the many field applications.

A robust wireless transport network is needed to make the connection between the powerful IP Core and the important end devices connected at the network edge, sometimes located hundreds of miles away. This wireless transport system must provide high capacity, low latency and support end-to-end, all of the Quality of

Service (QoS) and security enhancements through transparent, open-standards IP networking. Furthermore, this wireless transport system must be capable of scaling to thousands of end points over the entire oilfield as the field grows. In other words, the transport network must have the performance of a point-to-point microwave radio, but with the coverage of a point-multipoint cellular type system.

Redline's Virtual Fiber™ is a point-to-multipoint wireless system that is deployed like a cellular telephone network topology to blanket the oilfield, so that the equipment can be installed anywhere in order to support all of the applications required by the oil companies.
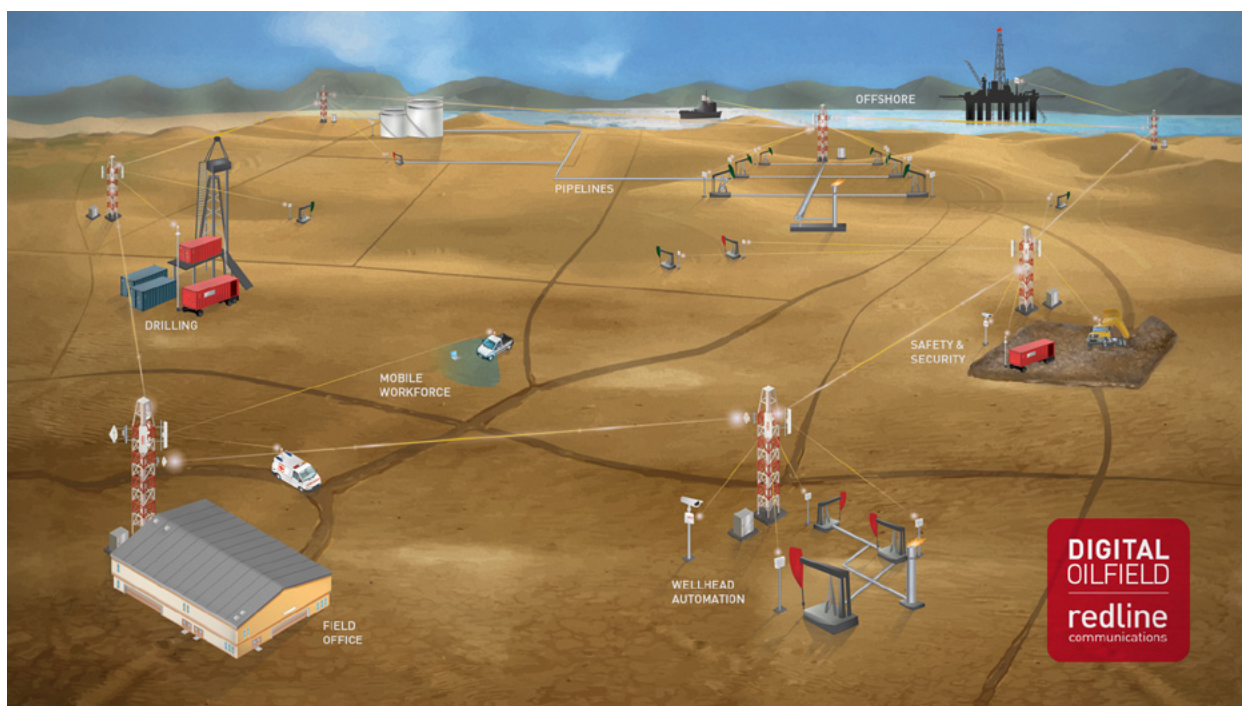
The Redline wireless portion consists of base station towers, typically located every 8 to 16 kilometers (and sometimes as much as 40 Km for lower capacity requirements), which create a ubiquitous and transparent Layer-2 wireless cloud of coverage over the field. Each base station sector provides coverage for a geographic sectorial area and supports multiple Redline remote terminals. Base stations can be installed with six, four, three, two or single sectors – depending on the capacity that the system is required to support.

Redline's Virtual Fiber™ system also offers point-to-point configurations which can support Gigabit capacity, sub-1 millisecond latency and all open-standards IP networking for transparent functionality. Redline's remote "field" wireless units are installed anywhere an edge network needs transport, such as wellheads, mobile drilling rigs, field offices, offshore platforms and even ship-to-shore mobile connectivity.

The main characteristics and benefits of this wireless network are:

- **Unmatched range/capacity:** The Redline system can allow a remote unit to connect with the base station at a top speed of 160 Mbps and at a distance of 8 – 16 kilometers (5 – 10 mi). For lower speed networks, ranges

up to 40 kilometers (25 mi) can be supported.

- **Non-Line of Sight (NLOS) functionality:** Redline units benefit from our experience with WiMAX/LTE, and implement the industry's most sophisticated diversity and MIMO techniques on both uplink and downlink transmission in order to offer complete NLOS functionality.

- **High performance, low latency:** Many of the applications that support EOR require real-time data with end-to-end latency below 8 ms. Other applications, such as operational video surveillance, require high data speeds that need Gigabit wireless network capacity. Redline delivers both high speed and low latency.

- **Complete L2/L3 interoperability:** Including rigorous lab testing with industry standard networking systems and automation systems and scores of field deployments around the world.

- **Guaranteed reliability and performance:** professionally designed network implementation for complete predictively for ubiquitous wireless coverage and data availability and performance

The Core Network

The core network drives many functionality, security and overall flow of the rest of the network. Architecturally speaking, like an enterprise network, much of an Oil & Gas company's core network will already be installed.

The core is usually divided into separate networks that are controlled by different areas of the operation:

- Process Control Network (PCN) will carry data, like SCADA and DCS, for M2M connectivity.
- Office network contains communication and collaboration tools, such as: voice, video, customer data bases, internal inventory control, ERP, CRM.
- Security network will contain the operational video surveillance network and the RF-ID inventory control.
- Network management system monitors and updates all devices the company supports.
- External access network allows third-party vendors to access the devices they support in order to make software upgrades and bug fixes.

A robust core is essential for the success of the Intelligent Digital Oilfield. The many protocols and devices installed in the operation and the myriad of different users who access the network (from many different entry points) require solid security and true QoS flexibility in order to support the core network. Designing the QoS for the core is crucial; Redline Engineering services are available for this task.

Security is another vital element in any Oil & Gas network. Existing policies for network security may determine the hardware and configuration used for the core. Designing third-party access will be the most challenging requirement. Although many people actively use the network at any time, the Intelligent Digital Oilfield is predominately a Machine-to-Machine (M2M) network where intelligent servers control equipment in the field, based on sensors also installed in the field.

These machines are provided by different companies, such as Emerson, Honeywell, Rockwell and Bosch. These companies support their devices with software upgrades based on automated feedback from the intelligent server at the core. The company that services the system will need access to monitor the server and, when necessary, make adjustments and software upgrades to the machines in the field. Usually, this vendor device

management is completely automated and requires no intervention; however, each equipment vendor needs access to the devices they support in the oilfield. This leads to the requirement for a Layer-3 network with either IPSEC tunnels to devices or MPLS tunnels. IPSEC is by far the most prevalent way to offer vendor access to the network, but either solution drives the requirement for this network to be based on a Layer-3 topology with QoS, security and vendor access being driven from the core.

The Transport Network

Connecting the edge to the core network requires a high-performance system with a long range. The largest expense in building out the digital oilfield is the infrastructure. Infrastructure includes building the towers at the base stations and tall masts at each remote site. The infrastructure expense is always the biggest line item on these projects because oilfields, unlike cities, have no existing towers or buildings where radios can be installed. The infrastructure can often represent as much as 60% of the total project cost. One of the reasons Redline has been extremely successful in this market is because its high-performance radio can reduce the infrastructure expense by as much as 20 times.

The other challenge in the transport network is supporting the many protocols implemented in end devices. Critical sensors on a fast moving smart drill rig require more data priority than a field-based email transmission, or an occasional RF-ID ping. Redline's Virtual Fiber wireless technology is software defined with customizable performance parameters to match the variety of devices in the field. A single remote radio can be programmed with separate and dynamic service flows to support serial data, video surveillance, Internet browsing and emergency voice lines from the same location. This guarantees that each application receives the specific parameters for data throughput it requires to operate as designed.

Ellipse
Sector Controller

Redline has developed a line of products specifically for the Oil & Gas industry that form a complete solution supporting all of the applications and usage models deployed in the field. And Redline provides this connectivity at the lowest price per area covered and megabit delivered.

At the heart of Redline's Virtual Fiber™ system is the RDL-3000 Ellipse Sector Controller radio for Base Stations. This radio combines our extreme performance backhauling technology with our experience in WiMAX and LTE to create the world's most powerful point-to-multipoint backhaul system for transport networks.

The RDL-3000 Ellipse is an all–outdoor, pure-IP broadband radio that connects to a sectorial antenna in order to create a coverage area within the oilfield. The primary value of the RDL-3000 is its extreme performance at long range. The RDL-3000 was designed to support all open-standards core routing protocols, unlike any other multipoint radio system on the market. In the Intelligent Digital Oilfield, this is most evident in Redline's support for key QoS features, military-grade security and high-resolution video.

Quality of Service: Redline spent years developing its wireless systems to support open-standards IP networking;

this is most evident in its QoS capabilities. The RDL-3000 can identify traffic flows or packet groups using the 802.1p Class of Service (CoS) field in the Ethernet packet. The RDL-3000 also supports 802.1Q-in-Q tagging in order to differentiate advanced multi-layer tagging coming from a MPLS core network. The RDL-3000 offers the absolute lowest latency of any wireless multipoint radio on the market. Through advanced 802.1p, Q-in-Q, and extremely low latency, the RDL-3000 can map all QoS fields transparently in order to support any possible Core QoS configuration. To facilitate QoS setup by trained partners, Redline uses the same command names and tag nomenclature as common core and edge networking systems in the radio management software.

Security: A properly configured network is all but intrusion-proof. However, none of this security is helpful if a wireless network allows an unauthorized access within the air media or interface points. This threat is known as the "Man-in-the-Middle" attack. A number of standards in the NIST and ITU were created to protect against this, such as AES-256 encryption standards and Elliptical Curved Cryptography authentication standards. One of the most stringent security certification is the U.S. Department of Defense's (DoD's) FIPS 140-2. This standard includes four levels of security and ten levels of tests to verify them. The tests search for encryption and authentication, and they verify the device cannot be opened, modified or accessed through a local interface, and that the remote management is a secure, protected virtual interface.

Video Surveillance: Operational video surveillance is becoming more and more common in the Oil & Gas industry right now. Much of the traffic coming in from the edge will be video surveillance used to improve operational efficiency and safety. Redline brings extensive experience in video surveillance to the Oil & Gas network solution, supports more cameras at higher resolution than any other wireless technologies, and has more large scale deployments than any other wireless manufacturer.

Edge Network

The number of applications installed in the Intelligent Oilfield is almost limitless. In the past, devices and applications implemented in the digital oilfield were severely limited by the capacity of the transport network.
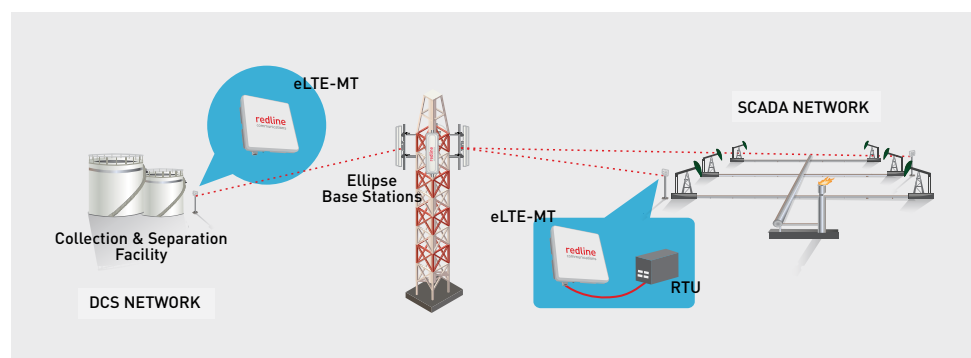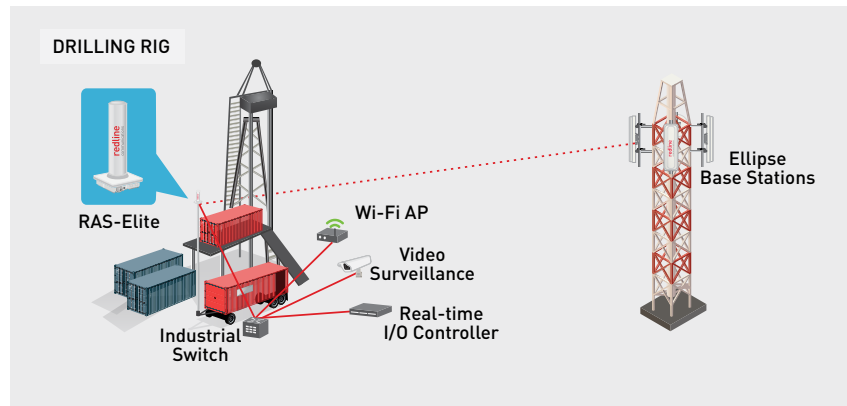

Redline's Virtual Fiber™ can provide a multi-gigabit backbone and allow for the installation of scores of IP-based systems, such as video surveillance, mobile Wi-Fi applications, SCADA, and others.

Drilling Rigs are constantly on the move, but they require a complete ecosystem of data communications. Traditionally V-SAT has been the communications of choice for the rigs. But the high latency and low bandwidth of V-SAT prevent Real-Time "Smart-Drilling," Video Surveillance, and 3-D subsurface modeling. Redline offers the performance to support all of the applications required at the drilling rig. Drilling contractors are lowering drilling days, increasing safety, and improving KPI's with better data communications.
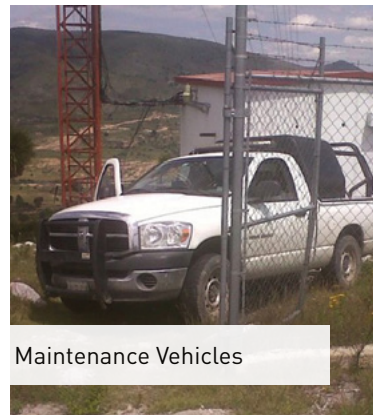
Redline's "Rapid Alignment System" (RAS) allows for automatic connectivity without any antenna alignment or
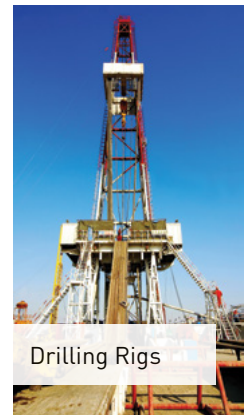
system configuration whatsoever. Simply install the RAS device on a Mobile Field Office, Drilling Rig, or Maintenance Vehicle. Field personnel simply power-up the device in the field for an up to 100 Mbps IP data connection is less than 10 seconds. The RAS device has the same range as our other remote units and the same great reliability. Redline's RAS is the perfect solution for the constant movement of assets in the oilfield.

DRILLING RIG

RAS-Elite

Wi-Fi AP

Video Surveillance

Real-time I/O Controller

Industrial Switch

Ellipse Base Stations

Mobile Field Offices

Maintenance Vehicles

Drilling Rigs

CONCLUSION

Oil & Gas companies need secure, high-performance wireless IP networks to support more efficient and more cost effective oil and gas extraction operation. Oil companies today are focusing attention on multiple service networks that support real-time applications and enable collaboration across the operation while maintaining a high level of security. The large amount and the variety of data collected from the field operation forms the 'Big Data' as inputs to oil & gas companies' private cloud for the different analytical tools, workflow virtualization software, and business optimization and decision making systems. This drives the need for an underlying networking infrastructure that guarantees the reliable and timely delivery of this massive scale and variety of data from every corner of the field operation. Together with industry leading wireline systems and automation solution providers, Redline Communications offer a variety of products for the core, transport and edge networks that meet the criteria to create an Intelligent Digital Oilfield.

Redline offers more capacity over larger coverage areas to any end device, with complete application transparency, true QoS, low latency, reliability and security, coupled with the full project cycle professional services provided by its experienced oil and gas HSE qualified engineers. It is this ability to offer a powerful and cost-effective solution to the challenge of the oilfield that has led to Redline's industry leadership in ubiquitous wireless coverage for entire oilfields in the Middle East, the United States, Latin America and Africa with some of the largest oil companies in the world. The result of purpose-built industrial networking equipment with superior performance, proven methodology, experienced professional service and total field interoperability is what makes the Redline wireless communications system the perfect transport medium for the intelligent oilfield.

ABOUT REDLINE COMMUNICATIONS

Redline Communications (www.rdlcom.com) is the creator of powerful wide-area wireless networks for the world's most challenging applications and locations. Used by Oil & Gas companies, militaries, municipalities and telecom service providers, Redline's powerful and versatile networks securely and reliably deliver M2M, voice, data and video communications.