Offshore Communications

Marine-Grade Microwave for Integrated Operations

Introduction

Offshore oil and gas exploration continues to expand at a rapid pace taking advantage of new technologies that allow operators to access energy sources farther away from shore than ever before. As offshore rigs, ships, floating storage and offload facilities and other vessels multiply and spread into deeper waters, the need for coordination between offshore vessels and with onshore facilities increases greatly. Advancements in industrial technology, changes in business models and tighter regulatory constraints necessitate closer monitoring, more remote control and maintenance of equipment, and more offloading of tasks and personnel from offshore to onshore locations. These trends greatly increase demand for capacity of offshore communications. Microwave is a much more cost-effective solution than marine optical fiber and it greatly surpasses the capacity and latency capabilities of traditional satellite communications.

Microwave communications with moving vessels over water present significant technological challenges. This paper discusses those challenges and shows how Ceragon's unique, innovative solution for microwave communications is the optimal technology for offshore applications.

Offshore Transport Network Challenges and Requirements

Offshore oil and gas operations are moving toward a new model called *integrated operations* (aka *digital oil field*, *e-field*, *field of the future* and *smart fields*). Integrated operations (IO) is a new work methodology for offshore oil and gas exploration, extraction and production. As its name implies, IO involves the interconnection and integration of facilities, knowledge, business units, processes, stakeholders and other resources and activities through intense use of information and communication technology (ICT). Whether the requirement is for

- always-on video-conferencing rooms between offshore facilities and onshore offices
- broadband access throughout platforms for collecting data

- remote control of mechanical and electrical equipment
- advancements in geological models and visualization
- constant monitoring, logging and analysis of data coming from offshore operations by experts
- or simply having internet access and television for the wellbeing of offshore workers

integrated operations signifies a breakthrough in the oil and gas industry. The ability to be virtually present on a rig from any location in the world provides an economy of scale that allows for reduction of the offshore workforce moving skilled and experienced professionals to safer onshore facilities where they can access and analyze data from multiple locations and mitigate risks in decision-making. IO is expected to streamline business processes with some estimates[1] predicting a 2-5% increase in oil and gas recovery, a 3-8% increase in production, a 15-30% reduction in operational expenditures and a 2-8% increase in well performance combined with a 25% reduction in offshore workforce

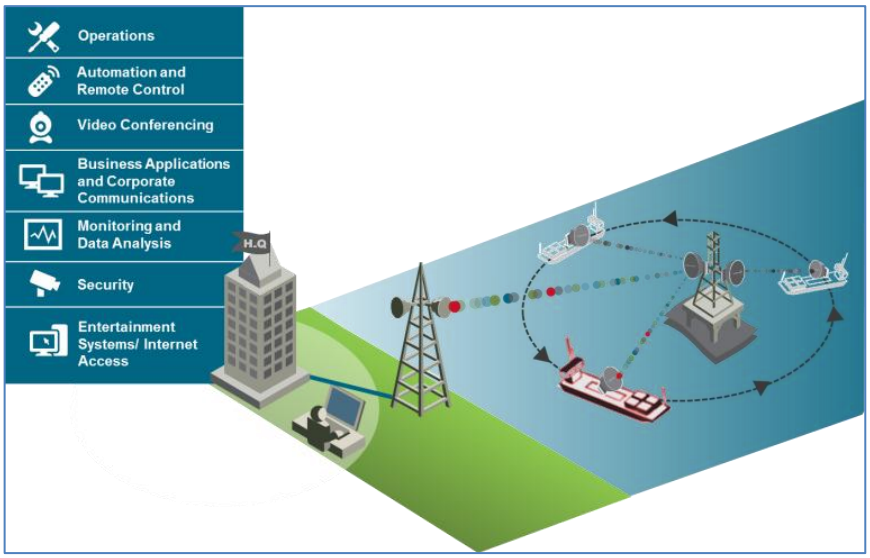

Figure 1 - Integrated Operation Enabled by Offshore Microwave Communications

This revolutionary leap in efficiency is given an even bigger boost by new safety and environmental regulations following the Deepwater Horizon accident in the Gulf of Mexico in 2010. Among the lessons learned is the understanding that better operation and risk management in emergency situations is possible through increased use of integrated operations and that IO can enable tighter monitoring of operations and reduced health risks for workers.

[1] ABB Group, February 2011

A highly reliable and resilient communications network is a basic building block in the realization of IO. One of the toughest challenges in this network is the *first-mile* connection from offshore facilities to land and to other offshore facilities. This connection is a critical link in the communications chain and has associated with it several mission-critical requirements:

High availability and reliability: The high level of risk (business, environmental and safety) associated with offshore oil and gas operations necessitates a highly available, reliable and resilient link. Loss of communications with an offshore facility can mean hasty evacuation of the facility costing the operator enormously in safety dangers, lost work time, and environmental hazards. Reliable communications keep onshore monitors in constant contact with offshore facilities.

Long distances: As oil reserves deplete and become exhausted, offshore operations move deeper into the sea to discover and tap into new reservoirs, moving them farther away from shore. Reliable communications must be maintained as the distance between facilities increases.

Durability in the marine environment: The highly corrosive environment of offshore operations puts a great strain on electrical and other equipment, and the measures needed to protect them. Communications solutions must withstand the difficult conditions of the marine environment over long periods of time.

High capacity: The transition to IO means more monitoring, more computer applications, more video and, generally, demand for more capacity. The few Mbps which were sufficient in the past are now growing by orders of magnitude to tens and hundreds of Mbps per facility rendering traditional communications inadequate.

Safety regulations: Ever-increasing safety regulations require that electrical equipment meet stringent safety standards such as performance in highly explosive environments.

Differentiated services: The use of a common infrastructure for different IO applications requires a high degree of control over quality of service (QoS) and dynamic provisioning of services according to different scenarios, for example, separation of mission-critical applications from employee entertainment systems.

Comparing Communications Technologies

The three main technologies used for offshore communications are:

1. Terrestrial wireless transmission (microwave)
2. Satellite
3. Marine fiber optics

The following table compares these technologies:

Medium	Capacity	Reliability and Availability	Cost
Standard Installation Microwave	**High** Hundreds of Mbps	**Challenging** Microwave communications over water from a moving platform present a challenge due to multipath fading, antenna misalignment and obstruction of Line of Sight	**Low cost** (compared to alternatives)
Marine-Grade Microwave System **(Ceragon's PointLink)**	**High capacity** **Hundreds of Mbps**	**High Reliability and Availability** **Uses unique advanced techniques to overcome over-water challenges and transmission from moving platforms**	**Moderate cost** **Low cost compared to alternatives, both in initial investment (equipment) and recurring costs (frequency licensing and maintenance)**
Satellite	**Low capacity** Typically 2-4 Mbps (insufficient for IO)	**High, but suffers from very high latency** Typically 250msec for geo-synchronous satellites	**High cost** Bandwidth leasing costs are high, especially for 24/7 communications. (typically 50K$ monthly per 2Mbps)
Fiber	**Highest** Hundreds of Gbps	**High**	**Highest cost** Whether in CapEx - deploying marine fiber, or OpEx - leasing marine fiber/maintenance, costs grow substantially as explorations move into deeper waters

Table 1 - Comparison of Different Media for Offshore Communications

As incumbent satellite communications are rapidly becoming insufficient for IO's increased capacity demands, and marine fiber communications are costly and time-consuming to deploy and operate, especially when operations move into deeper waters, microwave is the most cost-efficient method

for offshore-to-land and offshore-to-offshore connectivity. However, as microwave communications over water are inherently subject to multipath fading, line-of-sight obstruction and loss of antenna alignment (since offshore facilities float on the water), *standard* microwave communication systems cannot supply an adequate solution.

Ceragon's Unique PointLink Offshore Communications Solution

Ceragon is highly committed to the oil and gas industry maintaining a Center of Excellence in Norway dedicated to the research, manufacturing, training and overall business of offshore communications.

Ceragon's *PointLink* solution is an advanced microwave radio link system designed to provide connectivity on moving objects like platforms, drilling rigs, floating production and storage ships (FPSO) and the like. The solution consists of Ceragon's advanced Evolution Series Long Haul radio system connected to PointLink gyro-stabilized antennas which keep constant track and perfect alignment with their counterparts on offshore vessels and on land-based facilities. Overcoming the technological and physical challenges associated with standard microwave, the unique PointLink solution enables the application of highly efficient and cost-effective microwave communications for offshore links.

High availability and reliability: PointLink integrates highly reliable microwave equipment with customized antenna stabilization technologies and resilient paths and topologies:

Figure 2 - PointLink System Installation

- Evolution Series radios are highly reliable, with proven MTBF exceeding 70 years.
- As the water surface acts as a mirror reflecting signals, microwave communications over water is subject to multipath fading. To overcome multipath fading, standard space-diversity techniques can be implemented in less challenging cases. Ceragon's hybrid frequency and space diversity, *quad diversity,* scheme meets the availability-over-water challenges even for long distances. Quad diversity consists of two antennas on each side of the transmission, where each side transmits two identical signals at different frequencies from spatially separated antennas and receives both signals also by spatially separated antennas. This way, the effects of over-water multipath fading and temporary loss of line-of-sight (due to helicopters, cranes, drilling machinery, etc.) are mitigated, and mission-critical-grade availability is

achieved (99.995% - similar to the level of availability attained in onshore networks). Harsh sea weather and heavy precipitation can also be challenging. These are addressed by the implementation of links with high fade margins and by employing Ceragon's Adaptive Coding and Modulation (ACM) technology to keep the link up and running even in deteriorating weather conditions.

- The PointLink stabilized platform can accommodate parabolic antennas with diameters from 0.3 m/1 ft. to 3.0 m/10 ft. in various frequency bands depending on antenna size. The unique PointLink software is the only system that can control continuous 360 degree rotation and roll/pitch values up to +/-17 degrees. Combined with backlash-free servo motors, the pointing accuracy is kept as high as +/- 0.2 degrees. This innovative system is based on brute-force as opposed to other antenna tracking systems providing a spotless track record even in high vibration environments.

Figure 3 - Gyro Stabilized PointLink Antenna

On rotating platforms (e.g., FPSOs) the available antenna locations will normally not cover 360 degrees of unobstructed sight, so the system design must include multiple antennas. The PointLink system compensates for this problem as two or more antennas can be joined in a sector operation. Combined with hitless switch-over, PointLink ensures error-free 360 degrees operation year after year (A case study about the PointLink solution on a rotating vessel is available on Ceragon's website). PointLink systems are shipped with their own innovative GPS Gyro including a motion sensor for position, heading and motion detection making PointLink independent of any rate or angular sensors which are highly dependent on the environment.

Long distances: Evolution Series high power radios, part of the PointLink solution, are designed for long-haul applications with powerful transmitters and high system gain, enabling reliable communications over long distances. The current distance-over-water offshore link record holder is a PointLink system connecting mainland Norway to the Yme oil rig in the North Sea where the link spans 123 kilometers (Case study is available on Ceragon's website).

Durability in the marine environment: Evolution Series radios designated for offshore installations are specially coated for resistance to harsh marine environments. The entire system is enclosed in a protective radome.

High capacity: Evolution Series radios provide very high capacity. They employ 1024QAM modulation to increase spectral efficiency and transmit over 250 Mbps of Ethernet traffic over a single 28MHz channel. Alternatively, the same radios can be used for SDH transmission of STM-1s (155Mbps) or even STM-4 (622Mbps) using multiple carriers.

Safety regulations: The PointLink system is certified to comply with ATEX Zone 1 and 2 requirements making it suitable for safe work in highly explosive environments.

Differentiated services: Evolution Series radios are native Ethernet radios with a built-in QoS mechanism to handle prioritized traffic that supports differentiation of services as it guarantees bandwidth and appropriate latency for mission-critical services.

Figure 4 - Evolution Series Long Haul Radio Unit: ATEX Certified and marine-environment resistant

Summary

Offshore communications present many challenges to network planners and operators. The transition to deep-sea fields with moving installations together with the shift toward Integrated Operations and stricter safety and environmental regulations raise demand for high-capacity, reliable, and safe mission-critical communications systems. Microwave is the most cost-efficient solution for connecting offshore operations among themselves and to onshore locations. Ceragon's unique PointLink solution with Evolution Series radios and GPS gyro-stabilized antennas proves to be the most reliable and resilient solution for this application.

About Ceragon

Ceragon Networks Ltd. (CRNT) is the #1 wireless backhaul specialist. We provide innovative, flexible and cost-effective wireless backhaul solutions that enable mobile operators and other wired/wireless service providers to deliver 2G/3G, 4G/LTE and other broadband services to their subscribers. Ceragon's high-capacity, solutions use microwave technology to transfer voice and data traffic while maximizing bandwidth efficiency, to deliver more capacity over longer distances under any deployment scenario. Based on our extensive global experience, Ceragon delivers turnkey solutions that support service provider profitability at every stage of the network lifecycle enabling faster time to revenue, cost-effective operation and simple migration to all-IP networks. As the demand for data pushes the need for ever-increasing capacity, Ceragon is committed to serve the market with unmatched technology and innovation, ensuring effective solutions for the evolving needs of the marketplace. Our solutions are deployed by more than 430 service providers in over 130 countries.