Comprehensive Telecoms For Remote Oil & Gas Applications

By Wayne Nielsen

1. Abstract

With endlessly increasing demands on the world's oil and gas fields, it is becoming a necessity to have both secure and reliable data and telecom connectivity. Add to this the growing bandwidth demands for remote monitoring, reservoir optimization, video surveillance, and a host of other applications and it is easy to understand why current systems are groaning under the strain.

The solution is not always as obvious as it might at first appear, and each field will need a bespoke solution. After all, there is a limit to how many microwave dishes can be mounted in the correct attitude, yet subsea cables offer huge capacity but can be vulnerable to external damage, and satellite capacity remains heinously expensive.

Whatever the solution, it has to be a solution not for just today and tomorrow, but for the next 10 years or so. It must be resilient, maintainable and up-gradable and life cycle costs need to be considered rather than just build costs.

Network redundancy should be built in using the most appropriate local solution. Existing network pinch points need to be examined and eliminated. Permitting and licensing issues will need to be addressed. Back-up solutions and their limitations will need to be identified. Ongoing maintenance solutions will have to be defined. In-field communication requirements will have to be assessed and served

With such a cornucopia of requirements, demands and technical issues to consider, it is easy to understand why the subject is often put "on-hold." After all, hydrocarbon fields are there to pump oil and gas, and not to operate as a telephone exchange.

This paper will consider the perspective and needs of hydrocarbon companies with regard to their desire for high bandwidth submarine fiber solutions against the imposing realities of economics, permitting and legacy of "traditional" microwave & tropo-scatter, radio, satellite or cellular technologies. We will draw upon extensive oil & gas telecoms development and engineering experience in explaining how the submarine cables industry and ICPC could better serve this growing market in its infancy and beyond.

2. Technical Options to Consider

2.1. Submarine Fiber

Submarine fiber optic cables are much the same as inter-platform communication cables. They are physical cables laid on or under the seabed and consist of strands of pure glass little larger than a human hair enclosed in a cable which affords physical protection from the elements. Fiber optic cables extend to much longer distances without amplification than their predecessors, copper cables, and can carry orders of magnitude more traffic. The only real issue that differs from conventional oceanic subsea cable laying is the physical connection to the platform(s). Fiber cable connections to the platforms will always be secondary to those required for oil, gas and water injection. Further, where the riser cables are connected to a floating platform the cables will have a unique requirement to absorb wave and tidal motion.

2.2. Microwave & Tropo-Scatter

Microwave dishes are a relatively common sight on offshore platforms as they offer rapid connectivity for reasonable capacity demands. Transmission frequencies are from 2 to 25 GHz, with the higher frequencies used in short-haul private networks. Microwave transmission is useful when cable is difficult or impractical to use and a straight line of sight is available between two points.

Higher bandwidths are susceptible to weather conditions such as rain and fog because the shorter wavelengths are more easily absorbed by water. Decreasing the distance helps. The reliable range of the STM-4 links is somewhat less than the range of the lower-capacity technologies and an STM-4 hop length of less than 40km is a current planning guideline example.

Paths over water or other reflective surfaces like ice require height-diverse antennae to avoid fading due to reflections from the reflective surface. Careful control of power levels and antenna overspill areas allows frequencies to be re-used within a single network, easing radio spectrum demands and licensing requirements.

In oilfield applications, it occasionally becomes necessary to operate microwave systems beyond the usual limits of line-of sight distance. This is essentially a brute-force solution in that a high-powered transmitter sends a narrow beam to its horizon, and illuminates a region which is within line-of-sight of the receiving station. A high-gain receiving antenna can receive a signal refracted by the scatter region. Relying as it does on atmospheric turbulence and perturbations for scatter, the mechanism is weak and subject to considerable fading, requiring multiple diversity techniques to obtain a useful service, however a range of several hundreds of kilometers is possible in the humid tropical regions such as the Caribbean.

2.3. Radio

Ubiquitous on and around platforms and oil fields but limited in range and capacity, mobile radio is the day to day workhorse of oil field operations communications. Mobile radio and paging provide critical local communications for the safe and efficient operation of production facilities. To be highly effective, mobile radio is dependent on other technologies for the backhaul and trunking required for modern digital trunked radio or cellular solutions. Demand for frequency spectrum is putting tougher demands on mobile radio operators to squeeze more channels out of existing frequency allocations. In some cases regulatory bodies are mandating the reduction of channel frequency width and consequent upgrade or replacement of mobile radio equipment. Further pressure comes from the demands of commercial PCS, GSM and other 3G cellular operators for increased spectrum and the reallocation of some industrial frequency bands for these purposes.

2.4. Satellite

Satellite dishes are also fairly frequently seen on offshore platforms as they offer communications, without physical links, over any range, but at a price.

Satellite communication systems receive and transmit signals between earth-based stations and space satellites. There are “high-orbit” geosynchronous satellites, LEO (low earth orbit) satellites, and satellites in a variety of mid-orbits. Geosynchronous satellites are placed in high stationary orbits 22,300 miles above the earth, where they receive “uplink” signals from earth-based transmitters (or other satellites) and downlink those signals to earth. The downlink covers an area called the *footprint*, which may be very large or cover a focused area. The geosynchronous orbit is ideal because the satellites stay synchronized above a specific location. However, there are only so many slots in this orbit, and all the slots are taken above the most populated areas of the earth.

One problem with high-orbit geosynchronous satellites is that a typical back-and-forth transmission has a delay of about a half second, which causes problems in time-critical computer data transmissions. There are a number of applications for using satellites in data communications, but the time delays and low transmission rates must be considered. Some applications include videoconferencing, non delay-sensitive data transmissions, and temporary backup links.

2.5. Cellular

Cellular technologies and services are potentially useful for day-to-day oil field communications. Unfortunately, most oil fields and platforms are in remote and/or sparsely populated areas either too far from coverage or economically untenable for commercial operators. If cellular technology is attractive, field operators must often consider a private system which has attendant problems of spectrum licensing where frequencies may have been auctioned to commercial telecom operators. In the face of these barriers, focus often returns to private mobile trunked radio systems.

3. Impacting Issues

3.1. Aging Equipment

In the case of mature fields or platforms, telecom infrastructures are usually old, sometimes obsolete and invariably a “hotch potch” of individual systems, which have been added together over time without integration. In some instances, this agglomeration of systems comes about due to mergers and acquisitions among partners in an exploration or production area. Many times, it is simply a case of incremental communication needs being addressed one at a time as they arise over many years without any strategic telecom planning. As noted, before, the core business of the operating entity is oil and/or gas production, not the operation of a telecom network and priorities are apportioned accordingly. Aging systems still work, so the impetus to upgrade or replace them is low unless someone assesses potential productivity gains that new technologies may bring to the production of energy. What often seems to be overlooked when communication services are inevitably given second priority is that telecom and telemetry systems support mission critical functions in the production arena, and failure of those systems can stop or severely curtail production from a single well, a group of wells or an entire field.

3.2. CapEx and OpEx

Capital and Operational expenses must be considered in terms of life cycle costs including maintenance, backup facilities, upgrades and replacements. Telecom infrastructure capital and operational budgets often come under intense scrutiny out of proportion to the percentage that these budgets may represent of the overall capital projects or operational budgets involved. Because of this scrutiny budgeting must be accurate and as inclusive of all potential capital and operating costs as possible. Poorly budgeted projects are subject to chronic cost overruns which exacerbate the problem of quality telecom assets being perceived as necessary evils or luxuries.

3.3. Implementation Schedule

Implementation schedules must be carefully examined to ensure that telecom infrastructure is in place to meet operational needs. Equipment lead times must be considered as well as construction time frames. Certain specialized systems such as undersea cables may require time consuming seabed surveys, environmental permits and seabed easements unfamiliar to the oil field operator. In other areas frequency licensing may be extremely difficult and lie on the critical path. In some exotic climates, construction maybe limited to specific narrow windows for environmental and/or logistical reasons.

3.4. Survivability, Redundancy and Single Points of Failure

Network survivability is crucial where remote telemetry and control systems are deployed. Failure of process control networks for only seconds may result in production interruptions or slowdowns. Communication failure may also compromise personnel safety, particularly in hazardous environments, emergency situations and harsh climates. Survivability is a function of eliminating single points of network failure and implementing network redundancies. Budgetary constraints or priorities often conflict with redundancy requirements and the impact of production inefficiencies must be weighed against the cost of network survivability and the mean time to repair.

3.5. Strategic Planning and End User Bandwidth Requirements

To prevent the problems seen with “evolved” systems, it is important to look strategically at telecom requirements for the operation. This strategic evaluation should consider current needs as well as future requirements.

Current needs should be reviewed against end user bandwidth requirements. End user bandwidth demands are always varied, diverse and ever expanding. From the simplest telex channel which can operate quite happily on a radio link, to the most sophisticated remote control and monitoring functions, which consume huge bandwidth, there are a multitude of applications and processes which need to be served. Identifying each of these tasks and the demands they have on a communication network is a challenge. Links are often “taken for granted” and it is only when they are added together that the impact on bandwidth is identified.

Future requirements should allow for advances foreseen in both telecommunications and production technology as well as any potential requirements for remote operation of assets to improve productivity and efficiency. The analysis should consider upgradeability and examine the benefits of extra capacity against the additional capital costs.

3.6. Operational Risks

The operational risks to telecom systems must also be considered and evaluated. For terrestrial cable systems the risk of cable damage in either buried or aerial placement should be examined against future expected construction or excavation and/or weather. For submarine cable systems, the risk of cable damage due to fishing activities, ship anchoring, chafing or seabed seismic activity must be considered. For microwave systems, weather conditions such as heavy rain, cold temperatures or thermal inversions and other path conditions must be taken into account.

3.7. System Engineering and Design Efforts

A telecom system architecture and design must be developed from all the data, considerations and requirements assembled from the steps above. The development of the plan should include a review of telecom technologies, costs and integration issues. Systems may include fixed land-based systems, undersea systems, nomadic systems for such applications as roving drill rigs as well as mobile voice and data applications.

An overall network architecture and system design will form the basis for an effective economic model of the system.

3.8. Analysis for Network Model and Budget Model

Once the system architecture and design are complete the network may be modeled, and the capital budget developed. A well-constructed budget model will allow a variety of “what if” scenarios to be quickly and easily considered by identifying and altering key assumptions parametrically. The model should include operating cost estimates as well as capital costs so life cycle cost analysis may be performed.

3.9. Business Case Modeling

In addition to basic cost modeling, some operators may wish to consider different acquisition and/or operational strategies in addition to conventional “buy, build and operate.” These strategies might include lease, lease-back, third party outsourcing of services over dedicated facilities or other creative and unconventional scenarios. Any of these business options should be compared on a present value basis considering all life cycle costs.

3.10. Final Report cooperatively drafted with client

Ultimately, the results of all the data gathering and analysis must be tabulated, conclusions drawn with recommendations made and reported. Involvement of the client with the analytical process and the drafting of the report will result in the best chances of success for the effort. Reports can be written with due regard to client sensitivities while preserving the integrity of the data, results and recommendations.

4. Desired Effort Results

The end result of the process should be a well-planned telecom system which is well integrated with the oil and/or gas field or platform operations. The system must be designed to be cost effective and to seamlessly enhance the safety and efficiency of the production operation.

5. Conclusion

A remote, third-party view is often what is required to see a way forward for several reasons, including:

- Sufficient breadth and depth of telecom expertise does not exist within an oil/and or gas company,
- Many of the operational personnel are too close to the situation to look objectively at technology and costs,
- Company staff have too many other priorities to be able to complete a comprehensive integrated review in a timely fashion, and,
- Almost all oil and/or gas fields are owned and/or operated by consortia or partnerships of multiple operators. In this scenario, an independent third party's review may be perceived to be more objective with less "self interest" by the other owners or operators involved.

Author Biography

Wayne Nielsen (United States) has over 20 years of telecoms experience and developed and managed international projects in the Americas, Far East/Pac Rim, Europe and Middle East. He possesses a postgraduate degree master's in international Relations and is a member of the Institute of Directors (UK). In 2001, he founded WFN Strategies, which provides project/engineering of remote telecoms for Telecoms, defense and oil & gas industries. Responsibilities have included the planning and implementation of regional and global business strategies, including the organizing and management of the permitting of a proposed US East and West coast festoons, engineering of Gulf of Mexico fiber network, Prudhoe Bay multi-telecoms replacement system, and Caspian Sea submarine cable system. He is also founder and publisher of Submarine Telecoms Forum magazine (www.subtelforum.com), the industry's considerable voice on the topic, as well as on the Who's Who Register of Executives and Professionals.