SUBMARINE COMMUNICATIONS FOR THE OIL AND GAS INDUSTRY

STATUS AND EMERGING TRENDS

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Abstract: Submarine fibre optic cable systems are a proven solution for providing communications to off-shore assets in the Oil & Gas industry. The provision of high capacity, low latency communications allows increased automation and reduced manning to be built into the infra-structure design, resulting in savings on both capital and operational expenses. This paper considers the time-line for the development of a subsea cable system that is linked to an off-shore oil or gas field development, highlights the main technical considerations, identifies the key milestones and explains the major decision criteria. These will be compared and contrasted with the development and implementation of a more traditional, telecommunications submarine cable project.

1 INTRODUCTION

Over the past few years, the use of fibre optic communications to serve offshore Oil & Gas producing assets has continued to mature. Networks in the North Sea and Gulf of Mexico have reached a state of operational stability and continue to be expanded. Smaller networks and single platform cables in regions as diverse as East Asia, Brazil, and the Middle East continue to serve their owners, while new networks in Australia, West Africa and the Mediterranean are now being developed.

These networks and systems are as diverse as the regions they serve. Systems range in length from tens of kilometres to thousands. Either repeatered or unrepeatered technology may be employed. Systems can be entirely in shallow water (<200m) or descend to trans-oceanic depths to support platforms in water depths >2,000m. Sponsors may be major oil or gas producers, entities established for the sole purpose of providing offshore communications, or existing telecom operators. For the Oil & Gas companies, communications may be a small part of a large project to construct new offshore infrastructure or, alternatively, the subsea cable may be a standalone retrofit project.

Despite this diversity, some common themes emerge. All rely on standard telecommunications industry technology in both the wet and dry plant. In addition, it is not uncommon for specialised elements of wet plant to be introduced at the interface between the platform and the subsea system. Capacities typically range from 1Gb/s to 10Gb/s per offshore location served, upgradability to 40Gb/s is desirable but not essential. An emphasis on the health, safety, security and environmental aspects of a project is a prerequisite and applicable legislation and permitting, including the right to cross leased blocks, is always a major consideration

When compared to traditional telecom systems, both similarities and differences exist. The construction phase of the subsea system for an Oil & Gas project will be similar in duration to a telecom project of similar length, but the initial planning and contracting phase can be much more protracted. It should also be remembered that the subsea cable project will always have a lower priority than the needs of Oil & Gas production.

Although there are many similarities between a new field project and a retrofit subsea system, for the purposes of this paper, we will focus solely on the development of a subsea cable solution for a new field.

2 PROJECT LIFECYCLES & SPONSORSHIP

A new off-shore Oil & Gas field will have an implementation lifecycle, from concept to operation, of around 6-8 years; this is significantly longer than the 2-4 years that is typical of a telecoms project. Once operational, an offshore field will be expected to produce for 40-50 years, double the design life of a telecoms submarine system. The capital cost of a major offshore field development is on the order of 1 – 20BUS$, significantly larger than the 500MUS$ budget for the largest trans-oceanic submarine systems.

With the large capital sums involved, Oil & Gas companies are organized for, and are comfortable with, collaborating to develop new offshore fields. However, at present, they are far less comfortable with the concept of cooperation to build a subsea cable network between off-shore platforms; this is largely due to concerns regarding data security and network reliability. This contrasts with the established consortium model for submarine cable projects. It is also important to understand that communications and Information Technology (IT) are not core businesses for Oil & Gas companies and are, in the main, outsourced. This means that Oil & Gas companies will consider engaging in Build Own Operate (BOO) solutions only where no viable third party service provision is available. Getting a number of Oil & Gas companies to collaborate in a subsea network can be a major challenge. Ownership structures vary depending on the preference of the leading or "operating" company for each field. Some are comfortable owning and operating all fiber assets up to the interface with a national telecoms network, while others would prefer communications as a service. For either approach, the operating company will always have clear preferences with regard to the installation and ownership of platform risers and topside cabling,

The subsea system (whatever the solution) will only be a small percentage of the Capital cost of the field; this, combined with the fact that Oil & Gas companies only have small full time telecom departments, means that the subsea cable will have limited visibility and low priority within the overall project. This is, of course; significantly different to a submarine cable project where delivery of telecom service is the overall goal and the system RFPA date is the major driver for all parties involved in the project.

3 PROJECT VALIDATION

In the telecom industry, most major submarine cable projects go through a similar validation process. Initial concept leads to a traffic study, then to a feasibility study, including a Desk Top Study (DTS). Data gathering meetings will then allow traffic forecasts and projected revenues which can be compared to projected CAPEX and OPEX. This should be sufficient to commit to and Invitation To Tender (ITT) process and a supply contract will be signed if a predetermined level of capacity sales can be achieved and financing secured. From then on most submarine cable projects will be viable, as a continued steady increase in capacity demand can reasonably be expected.

A subsea system for the Oil & Gas industry is very different. Firstly, it is only viable if the field development is viable and the viability of the field in turn depends on the current and forecast price for oil or gas.

An offshore field project commences with a lease purchase, then exploration (survey/pilot drilling) and, from the data gathered, an assessment of the field reserves will be made. If this assessment is promising, it will initiate a significant investment of time and money in a Front End Engineering Design (FEED) program. Most Oil & Gas companies now recognise that the high capacity and low latency provided by fibre optic cables can facilitate increased levels of automation. This reduces the requirement for human support offshore, thus reducing capital cost as well as annual operating costs, while increasing field operating efficiency and also improving personnel effectiveness. As a result, the FEED program will often include a feasibility study for a subsea fibre optic communications solution. Options for the study can include Build Own Operate (BOO), Build Own Lease for Service (BOLS) and pure service solutions.

Once the FEED program is completed, capital and operating costs are compared with expected revenues, based on field reserves, projected field life and actual/forecast oil and or gas prices. This comparison will lead to a Final Investment Decision (FID). As the subsea telecom cable is only needed if the field is viable, the success or failure of the telecom cable project will depend not on its own merits but on the overall decision to develop the field. A large investment can be made in FEED, stimulating interest in the subsea system and then, if market conditions are not right to develop the field, FID can be deferred, leading to disappointment on the part of potential suppliers.

4 LEGISLATION AND PERMITTING

In recent years Governments have recognised the importance of submarine cables to the global economy and many countries are making significant strides in legislating for the installation, protection and maintenance of submarine cables in their territorial waters and Exclusive Economic Zones (EEZ). Also, thanks to the efforts of the members of the International Cable Protection Committee (ICPC) the United Nations is taking steps to refine the United Nations Convention on the Law of the Sea (UNCLOS) as it relates to submarine cables. This means that in most countries the process of identifying and obtaining the necessary licences and permits to install and operate a submarine cable is relatively straight forward. However, subsea cable systems to offshore facilities within EEZs are another matter.

The Australian Government is probably the most advanced in its development of legislation for submarine cables. The *Telecommunications Act (1997)* administered by the Australian Communications and Media Authority (ACMA) is the principle statute that lays out requirements for installation of submarine cables in Australia. However, subsea cables to offshore assets were not in contemplation when it was drafted. In order to facilitate offshore Oil & Gas exploration and production the Australian Government enacted specific legislation, the *Offshore Petroleum and Greenhouse Gas Storage Act* 2006 (OPGGSA). The OPGGSA does not specifically address subsea cables and, perhaps surprisingly does not deal with the issue of cables crossing leased blocks. As Australia is a signatory to UNCLOS, one might expect that it would legislate to protect the right of a submarine cable to cross a leased block and how such a crossing can be negotiated with the lease holder. This is not the case.

Opinion of legal experts in Australia is split roughly 50-50 on whether the *Telecommunications Act* or the OPGGSA will be the appropriate legislation to administer subsea cables. If this dilemma exists in Australia it is likely to manifest itself in other countries where legislation has been enacted to take advantage of Oil & Gas reserves in EEZs.

5 HEALTH, SAFETY AND THE ENVIRONMENT

The importance of Health, Safety and the Environment (HSE) in Oil & Gas projects cannot be overemphasized. The risks to life, property and the environment inherent in energy production are very real and must be managed throughout a project. Because of their position in the public eye, Oil & Gas companies feel obligated to impose their own HSE requirements on the operations of all their suppliers. Some companies have tiered systems whereby work offshore comes under more scrutiny than, say, work at a suppliers' factories, while others may apply the same requirements across the board.

During a submarine cable installation project, HSE requirements will manifest themselves in a number of ways. At the highest level, written policies and a corporate commitment to HSE are expected. Work practices must be documented. Proper training is required; this includes helicopter safety training. Audits, including vessel audits, will be conducted. Hazard Identification (HAZID) is a well known part of any Oil & Gas activity. All work activities must begin with a discussion of any safety implications. Any work performed offshore, including terminal equipment installation, must be done in accordance with stringent safety practices.

6 SYSTEM DESIGN

The design of systems serving offshore facilities draws upon the core technologies of the submarine cable industry and supplements it in several important ways. Resiliency and survivability will take precedence over capacity, efficiency, and cost. This has led to a number of innovative system architectures which use both fibre routing and OADM to ensure that the network can continue to serve active locations, even if several platforms are disconnected or out of service.

In the submerged plant, cable, joints, repeaters, branching units, and wavelength filters are all identical to those used for telecom systems. Where the cable leaves the seabed and connects to the offshore platform, new elements must be introduced. In a shallow water platform, standard cable types and retrofit riser systems protected by Uraduct™ may suffice. In deeper water, specialized Dynamic Riser Cable (DRC) will be needed. This will be pulled through an 'I' or 'J' tube to a hang-off point on the platform. At the bottom end of the tube, a bend stiffener must be attached. At the top end, the cable must be terminated and connected to top-side cables which will carry the fibres to the equipment room. Topside terminations can be as simple as a tri-port splice, although there is a trend towards connectorized solutions.

Many new field developments include fibre optic bundles in the fluid risers installed for Oil & Gas production, and these fibres may be used rather than installing a new DRC. Where this is the case, the submarine cable must be terminated in a subsea housing and a connectorized hose or flying lead used to connect to the riser termination. The flying lead will be deployed on a pallet and installed using a Remotely Operated Vehicle (ROV). While this approach eliminates the time and expense of installing a new riser, it introduces subsea connectors, flying leads, deployment pallets, and termination assemblies. These elements of wet plant are readily available, but often require customised engineering to integrate the subsea cable and an existing riser. For systems using remotely pumped amplifiers or Raman amplification, the subsea connectors may introduce limits on transmitted optical power levels, thus limiting the system span. Some planned systems will serve Floating Production Offload and Storage (FPSO), rotating platforms and may incorporate Fibre Optic Rotary Joints (FORJ) in the transmission path; this introduces significant attenuation and, like subsea connectors, may limit transmitted optical power. Where it is not possible to move the terminal equipment to the non-rotating portion of the platform, innovative solutions will be needed to permit long haul transmission through a FORJ.

Electrical safety is another concern for the design of Oil & Gas systems. While it is not necessary to place power feed equipment on offshore platforms, access to the electrical conductor improves the ability to locate and maintain the cable by permitting DC testing and electroding. In spite of this, some Oil & Gas companies are taking the view that any electrical connection is undesirable and permanently grounding the cable conductor at both the top of the riser and at any submerged termination points. It remains to be seen if this is a satisfactory solution or if it will create long term issues for cable fault location and the duration/cost of repairs.

The dry plant employed for Oil & Gas systems is essentially the same as that for traditional systems. 10Gb/s channels are generally sufficient, although given planned field lifetimes, some ability to add channels or upgrade to higher channel rates is generally desirable. Equipment room space on offshore platforms is often very limited, so there is some advantage in having compact shelves and moving ancillary equipment such as network management servers to the shore terminals.

7 PROJECT MANAGEMENT

Project management of subsea systems for the Oil & Gas industry differs from that of traditional submarine systems only in the level of effort involved. An Oil & Gas project has a large number of interested parties, including project sponsors, offshore operations managers, the system supplier, survey providers, secondary suppliers and subcontractors, permitting authorities, QA and HSE representatives, operators of third party vessels, backhaul providers, end users, and others, all of whom must interact with the project team. For many of these, it will be their first fibre optic project and there is little or no precedent for them to follow. Engagement and communication with these interested parties are vital. Action lists can quickly grow to hundreds of items. Weekly coordination meetings and delegation to working groups are essential to maintaining project work flow.

8 MARINE OPERATIONS

Marine operations associated with Oil & Gas projects often entail activities outside the normal scope of a telecom industry project. This begins with survey operations, where the Oil & Gas industry is moving towards the use of Autonomous Underwater Vehicle (AUV) surveys rather than traditional survey vessels with towed or hull mounted systems; this can be faster and more cost effective, but eliminates the possibility of adjusting the route in real time. Data is collected from the AUV at intervals of 48 hours or more and must be processed and reviewed; if a viable route is not found, additional survey lines must then be programmed and run to allow route development.

Requirements for main lay vessels will depend on the location and operating companies involved. Vessel audits must be up to date and may go beyond merchant marine requirements. Planning for Simultaneous Operations (SIMOPs) becomes a concern if there are drilling, survey, or other vessel actives in the area. The Oil & Gas operator will want to place their reps on the installation vessel(s) and this may include dedicated safety and HSE personnel. Security Zones, typically 500m, will exist around all platforms and strict operating procedures will govern vessels entering these zones; additional navigation and warning systems may be needed to operate safely in the vicinity of oil production platforms.

9 OPERATIONS AND MAINTENANCE

The need for on-going Operations & Maintenance (O&M) of communication systems for offshore Oil & Gas should not be overlooked. If and when a fibre optic cable is out of service, the platform operations will have to fall back on the use of satellite or occasionally microwave services. Since no system can be assured of 100% availability, such contingency plans are always necessary. However, the loss of fibre optic communications, especially after operators have grown accustomed to them, will pose a burden and may result in reduced operating efficiency. To ensure outages are kept to a minimum, comprehensive maintenance plans must be put in place.

Recent changes to some of the zone agreements, has made them a more attractive option for Oil & Gas operators. Standard telecom industry maintenance practices are suitable for large portions of the system outside the platform Safety Zones. However, should a repair be required close to a platform, it is likely this would entail a detailed planning effort and dedicated project management. Dry plant maintenance may be performed by a dedicated team, or outsourced to those already providing maintenance for other communications and IT services on the platform.

10 EXISTING AND PLANNED SYSTEMS

Some of the more notable uses of optical fibre cables by the offshore Oil & Gas industry are:

Petrobras, who installed one of the earliest offshore fibre systems in the late 1990s, is planning additional fibre infrastructure.

Tampnet owns and operates a network of 1,200km of fibre in the North Sea.

The BP Gulf of Mexico Fibre Optic Network backbone spans 1,200km from Texas to Louisiana.

There are a number of projects in the planning stages in West Africa.

Several developments are underway in Northwest Australia.

This list is not exclusive, as many projects remain confidential or are in early stages of planning.

11 EMERGING TRENDS

Since 2006, when the authors conceived and specified the first backbone and spur system design for the BP Gulf of Mexico network, similar network designs have been proposed for offshore fields around the world. Like the GOM network, most new networks will require a phased approach in which the backbone and a few platforms are installed first, with expansion to new platforms occurring over many years. Multi-purpose networks, in which the backbone provides a telecommunications service, while spurs support offshore platforms, are also under consideration. The technical challenges of this approach are well understood and can be managed by most suppliers and owners.

The ownership challenges can be more difficult to address. At present, the trend is for separate supply contracts to be let for each new platform connection. The original owner will be responsible for maintenance of the backbone, but each spur may entail separate wet and dry maintenance contracts. This approach is inefficient for both the owners and suppliers as it duplicates the administrative costs of installing and operating the system. Unfortunately, this has come about because each platform owner has its own set of policies, procedures, specifications, and requirements for working on or near its platforms. Where the spurs connect platforms operated by different companies, the package of requirements for each platform is likely to be unique.

Trying to capture all these disparate requirements into a single, conventional supply contract can be difficult and time consuming to achieve. This being the case, there could be some merit in considering an alternative contract model based an overarching contract for the majority of the system supply, linked to a set of subsidiary contracts, one for each platform to be connected. Under the subsidiary contracts, the expectations of each platform operator can be met separately and not be imposed on the rest of the supply contract. This type of contract model would also allow new spur connections to be added at a later date without the need to repeat or re-iterate basic supply contract functions such as quality audits of the cable factory.

To date, the submarine cable industry has been flexible with regard to customer requirements, but there is certainly room for improvement. It is not unusual for years to pass between initial inquiry and contract signature, even for projects which extend an existing network. Ideally, as additional experience is gained, a set of standard product offerings, combined with a standard set of contract terms known to be acceptable to all or most of the major oil companies should emerge. As the Oil & Gas and submarine telecom industries work together more frequently, trust in each other's capability is bound to emerge. An added benefit will be the ability of an experienced supplier to deliver and support multi-purpose networks using technical and contract terms suitable for both the telecom and Oil & Gas industries.

12 OUTLOOK AND CONCLUSIONS

Based on experience over the last few years, the authors estimate there is on the order of $100M per year potential revenue related to the supply of fiber optic communications infrastructure to the offshore Oil & Gas industry. This is not going to "save" the traditional submarine telecom industry but can be an important contribution to overall revenues.

Suppliers, consultants, marine operators all have a need for individuals and teams that recognize the unique aspects of working with the Oil & Gas industry. The ability to adopt new and flexible business models, technical practices, and project management styles will enable the submarine telecom industry, both to serve the offshore Oil & Gas sector and to improve service to our traditional client base.

13 REFERENCES

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[2] http://www.tampnet.com/home retrieved on 17 February 2013.

