UPGRADES TO OIL & GAS FIBER OPTIC NETWORK; 2018 MARINE CAMPAIGN

Rich Rogers, Sean Stanley, Albert Carpinteyro, Tom Gould (SubCom)
Email: rrogers@subcom.com

SubCom / Oil & Gas / Scientific 250 Industrial Way West, Eatontown, NJ 07724 USA.

Abstract: The BP Gulf of Mexico Fiber Optic Network was commissioned 10 years ago to provide high bandwidth connections to multiple offshore oil and gas (O&G) platforms. The system was designed to be upgraded by the addition of branch legs from new or existing stubbed branching units. In 2018, three additional platforms were connected to the network, bringing the number of platforms with direct connections to shore to 16. From factory integration through final splice to confidence trials, the hookups to these three platforms presented operational challenges that required close collaboration between customer and client project teams to coordinate Marine Installation, Commissioning & Acceptance, Design Engineering, Platform management, Network Management, and project oversight. The effort included a dynamic riser pull-in to a floating platform, trunk cut-in of a new branching unit, installation of five wet-mate connectorized subsea units, six optical flying leads, and connection and termination of three dry mate riser connectors topside. This paper relates the implementation experiences encountered during this intensive campaign, which is highly relevant to the industry as the alignment between O&G and subsea telecom continues.

1. BACKGROUND OF BP GOM FIBER OPTIC NETWORK

In 2005, hurricanes Dennis, Katrina, and Rita swept through the Gulf of Mexico, hindering offshore O&G asset operations in their respective paths. Evacuation procedures require that restoration of communication be in place in advance of personnel returning to the asset, meaning that assets looking to return to normal operations would see delays due to the loss of communication during and after storms. In response to these events, BP Americas, one of the major Gulf of Mexico (GoM) producers, pushed forward with an initiative to implement a robust, flexible, high-capacity fiber optic communications system. Currently serving 16 platforms with base speeds of 10-100Gbs, the BP GoM network has proven that reliable bandwidth is a strategic investment that improves production, safety, and quality of life for the crew. Originally designed for a capacity of up to 64 platforms, the BP GoM fiber optic network (FON) is continuing to attract owners and operators due to an ever-increasing number of sensor and instrument data streams for storage and analysis, which are critical to real-time production decisions. The diverse nature and location of GoM assets considering subsea fiber connections requires an equally diverse range of products and approaches. Within the last year, SubCom has added three additional platforms, each of which brought their own challenges and unique product implementation strategies. The following sections address each implementation and the specific challenges encountered beyond the scope of typical subsea fiber lay.

2. CASE ONE: A DEEPWATER RISER INSTALLATION

In Case 1, SubCom's Dynamic Riser Cable (DRC) was installed from a SubCom owned and operated cable laying vessel. SubCom's DRC is a torque-balanced armoured cable specifically designed for floating platform applications in cases where a dedicated fiber network riser is needed. Coupled with additional abrasion protection and straking, the DRC catenary reached a touch down point of approximately 1600 meters water depth near the platform. Closer to the touch down point, the cable segment also included SubCom's Fiber Distribution Canister (FDC). This in-line subsea body mounted on a mudmat allows for multiple wet mate fiber connections and configurations based on customer requirements; in this case it is used to provide connectivity from the platform to a Riser Monitoring System (RMS).

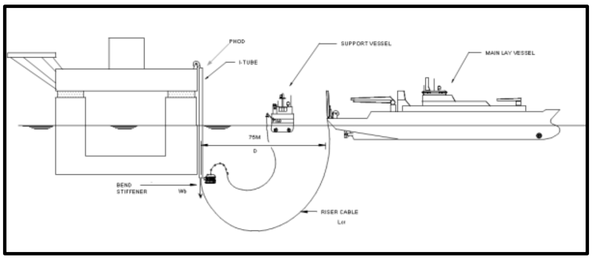

Figure 1: Riser Installation Pull-in Prior to Lay Away

The RMS system sensors and hardware were designed by the customer and installed on other platform risers, while the required connectivity path to the topside receivers were manufactured and installed by SubCom. The customer RMS hub is connected to a SubCom Deployment Pallet (DP) with its own wet mate connector (WMC) interfaces via an Optical Flying Lead (OFL). A segment of submarine cable links the DP near the RMS to the DP landed near the FDC. OFLs serve as the links between the RMS and DP as well as between the DP and FDC. Fixed OFL lengths between 100-150m required the marine installation team to accurately land the mudmats within a small (5m) target box on the seabed. The final WMC connections were performed by a support vessel's remote operated vehicle (ROV).

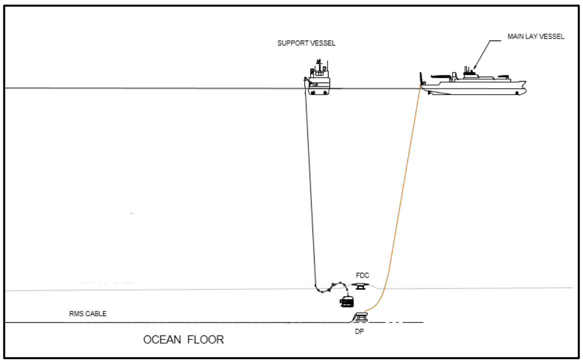

Figure 2: Landing DP near FDC

A connectorized platform hang-off device (CPHOD) was secured upon receipt of the cable end at the top of the column. The topside termination integrates a dry-mate fiber connector to the DRC, a product which was qualified in close cooperation with the customer. This step proved a considerable time and safety improvement over a traditional transition cable and splice. In a standard PHOD, the cable is secured, and a transition cable is prepared and spliced, a process that requires the cable vessel to wait an additional 10-16 hours and hold position within the 500m zone in order to wait to test fiber paths and lay away. A CPHOD approach allowed for nearly immediate segment testing, reduced topside cable handling, minimized scaffolding work, and reduced vessel time.

Through the course of early engineering phases, several site visits in the shipyard were performed for engineers to design a custom winch solution that could be mobilized offshore. A fit test of the finished winch skid was performed prior to platform sail-away. This proved to be a prudent step, resulting in shipyard-completed weldment changes that reduced mobilization time and hot work offshore. This design criteria, coupled with storage restrictions offshore, required very close coordination between customer, winch supplier, and SubCom engineers to successfully land the winch skid in position above the pull tube. The use of 3D modeling with customer provided drawings allowed the team to visualize the installation and removal paths, which avoided various pipes, cable racks and other hard points when maneuvering the winch into position.

Deepwater platforms are designed to allow for lateral movement; consequently, risers and flow lines are designed to assume several catenary profiles over their lifetime. Models used to determine platform position and the relative position of its various risers must include data on environmental extremes, such as extreme hurricane force winds. Classified as 100-year and 1000-year events, statistical outliers are used to predict the rare climatological forces that would place the platform in positions outside typical range of motion. The regulatory standards these model inputs are based on can change while construction is already well underway, leading to a re-analysis of design and utilization values, which was the case on this project.

An update to the climatological models prompted the project team to look at component engineering as well as route stability under the extremes of riser movement. A diver-less bend stiffener connector (DBSC) was used to secure the DRC Bend Stiffener to the existing I-Tube structure on the platform. The DBSC, bend stiffener, adaptor plates, and various hardware form the system that provides a safe pivot point and bend radius as the DRC transitions from below the water-line to a topside termination. The design was re-visited once new stress values were available and the working groups were able to confirm no re-manufacture would be required.

However, the new stress and position locations did impact the cable lay route. Concerns over nearby seabed contours coupled with newly added cable forces prompted a significant re-work of the route plan near the platform. Once again, the project engineers of all parties agreed to a set of changes designed to mitigate the stability concerns, while keeping an installation-friendly path.

3. CASE TWO: ISOLATED DEEPWATER ASSET WITH FIBER READY HARDWARE AFTER 8 YEARS IN THE FIELD.

Geodiversity of offshore lease blocks can spread a single operator's assets across the gulf. Companies may take advantage of clustered assets for redundant data links nearshore, but as facilities reach greater depths, this technique is no longer feasible [1]. This single-spar platform in 2400 meters water depth had no immediate neighbors, and its distance from the repeatered BP GoM backbone neared the transmission limits for an unrepeated branch in the GoM system. With a fiber length of more than 150km, this segment required higher optical power Raman amplification and a Remote Optical Pump Amplifier (ROPA)for added reach.

In this case, the platform had an existing umbilical and therefore a separate riser installation was not required. The existing umbilical was outfitted with a Topside Umbilical Termination Assembly (TUTA). The TUTA had several dry-mate connectors available to allow for the topside cable connection to the platform communications room. On the seafloor, the umbilical was terminated on a previously deployed subsea umbilical termination assembly (SUTA) with suitable wet-mate connections. SubCom landed a DP near the SUTA at a depth of 2450m, laid the branch segment, then recovered and spliced the segment to an existing BU stub for this installation. The final link from DP to SUTA was completed via OFL connection.

Prior to transmission testing and commissioning of the link, it was necessary to measure back reflection at fiber end faces on the dry mate and wet mate connectors. The transmission solution included Raman amplifiers with optical power levels in the hundreds of milliwatts. The dry mate connection on the platform was identified as a critical interface where back reflection had to be minimized.

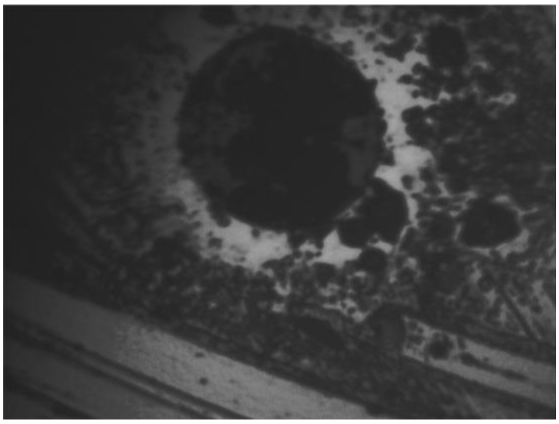

Figure 3: Dirty Fiber Surface on a Dry Mate Connector

Clean end face surfaces were required for low back-reflection level. Though protective caps had been in place since initial installation, the unmated fiber end face is a magnet for the deposition of vapor and particulates over time. Engineers working topside used a fiber scope to take before-and-after images (see Figure 3) to support the cleaning process. Cleaning was performed on both plug and receptacle connectors with tools and processes that had been refined and practiced by installation engineers in the development lab. Once cleaned and mated, images and back reflection measurements were given a final review by SubCom engineers in Eatontown, NJ. After confirming acceptable condition of the transmission path, Raman amplifiers were activated, and commissioning proceeded.

4. CASE THREE: A NEW DEEPWATER PLATFORM IS MADE READY FOR SERVICE ON THE GOM FON WITH THE ADDITION OF A NEW BU AND BRANCH LEG

The GoM FON initial system equipage included 19 Optical Add Drop Multiplexing (OADM) branching units, SubCom's largest deployment of OADM technology to date [2]. However, newer platform tie-ins did not always align with existing BU locations with respect to optical transmission solutions and route engineering. For Case 3, it was necessary to cut into the trunk and insert an additional BU and repeater to support the branch to a new deepwater facility.

With two paths to shore, as well as dual power feeds, the BP GoM system has flexibility for its users to re-route traffic in the event of a cable cut on the trunk cable with minimal impact. This architecture allows for the expansion of the trunk via a planned cut. Working closely with the network operators, a re-route of traffic and careful power safety procedures were planned for the cut-in operation. Power switching BUs form the backbone of the cut-in procedure. By altering the configuration of these BUs, and powering to a grounded BU on each side of the cable segment, SubCom can isolate the span that will ultimately be cut.

Power Safety coordination is a critical safety practice when a live system cable poses a risk to personnel handling cable on deck and in the joint shop. A power safety plan includes isolation of a cable segment, 24-hour safety coverage in each cable station (typically unmanned), a power grounding safety unit (PGU) on the cable ship, as well as a solid communications plan.

The cut-in was performed by a SubCom Reliance Class Cable Ship. Using a work class ROV for touch down monitoring, another DP was deployed near the platform SUTA at a depth of 2225m, for later connection via OFL. A segment of under 30km was laid towards the cable trunk and placed on a cable buoy. The vessels proceeded to the BP GoM FON trunk and, upon receiving power control from the landing stations, the WCROV made the planned cut in the trunk cable. One end of the cable was recovered and buoyed while the other end was recovered to the vessel for integration with the new BU along with the branch leg cable that was previously buoyed. Once the first two legs of the BU were integrated, the BU was deployed to the seabed. The remainder of new trunk cable and repeater were then deployed. The final splice on the trunk was completed by recovery of the final cable buoy. Once spliced, the BU configuration on the trunk was returned to its normal state allowing traffic flow to be restored to original configurations. The platform is nearing completion and SubCom team completed commissioning of this segment in early 2019.

5. CONCLUSION

The BP GoM fiber network design has proven itself as a robust implementation of an upgradable, flexible network. SubCom has safely completed several diverse product implementation challenges in the last year with close coordination and support from customers, third-party SME's, and rigorous safety planning. The successful installation of a dynamic riser, trunk cut-in of a new branching unit, and installation of wet-mate connectorized DPs, optical flying leads, and dry mate riser connectors have brought high speed, reliable connectivity to three additional platforms, improving productivity and safety.

6. REFERENCES

[1] R. Munier, D. Buffitt, R. Thomas, "BP GoM Fiber Optic Network: A Case Study", SubOptic 2010.
[2] R. Munier, J. Mendez, "Undersea Fiber Systems for Oil and Gas Applications", Sea Technology, April 2009 pg. 27
[3] R. Munier, K. Haaland BP, "GoM: Next Generation Offshore Fiber", ON&T October/November, 2008. Volume 14 Issue 7 pg. 44
[4] R. Thomas, G. Tully, M. Spalding, D. Buffitt, J. Mendez, R. Munier, "Long Term Real Time Observatories for Environmental Monitoring in Offshore Drilling and Production Areas", SubOptic 2013
[5] Q. Zhong, "Communications Technology Evolves to Better Serve the Offshore Industry", Sea Technology, May 2008 pg. 25
[6] R. Thomas, J. Mendez, L. Garrett, "Modular Connections in Subsea Cable Projects: Can Subsea Telecom Benefit from O&G and Scientific Connection Methods?", Submarine Telecoms Forum September 2018 Issue 102 pg. 10

