NEW CABLE, NEW PLAYERS, NEW REPEATERS IN BRAZIL ON TIME AND ON BUDGET: CAN ALL THIS BE POSSIBLE IN THE SAME SENTENCE AND IN THE SAME PROJECT? ADDRESSING THE CHALLENGES OF DEPLOYING A NEW CABLE IN SOUTH AMERICA

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Abstract: Subsea cable builds are as much about technology as they are about planning and sophisticated project management, and sharing lessons learned contributes to the overall advancement of the industry. Submarine cable projects are never short of challenges but embarking on a Project JUNIOR to build a new cable in Brazil with an unorthodox approach, raised the bar a number of notches. This paper describes how the supplier team formed in 2016 by Submarine cable and repeater manufacturers, installation fleet, and customer, took on the challenge, and succeeded. From the start, the customer pushed the mind-set of innovating in the technology and in the execution, allowing the team to propose out-of-the-box solutions to reduce cost and ensure high quality and timely completion.

Some of the “uncharted waters” were:
- Hiring a new player to prime the project
- Splitting the Marine Survey in a separate contract
- Open Cable OSNR driven design
- Unique 8FP deployment: 6FP repeatered, 2 unrepeatered
- Deploying a brand-new repeater and how to de-risk it
- Integration of repeaters and cable at the vessel
- Navigating and ship permitting process
- Timeframe for Environmental permits in Brazil

Those topics, along with other key project challenges and lessons learned, are covered on this paper.

1. IT IS NOT ALL ABOUT TECHNOLOGY

Building a subsea cable certainly includes complex technologies, however there is much more involved on such challenging projects.

Technology wise, most of recent cables have been adopting an approach known in the market as “Open Cable”, meaning basically that the cable built (the wet plant) is decoupled from the SLTE – Submarine Line Terminal Equipment (part of the dry plant). That implies that the cable system is designed and built under some key parameters guidance such as OSNR (Optical Signal to Noise Ratio) and GOSNR (Generalized OSNR), and any typical SLTE available in the market could be used on this system.

For building the Junior Cable, named after the late Brazilian painter José Ferraz de Almeida Júnior (1850-1889) , the Open Cable OSNR concept was used, however, a team of providers of Submarine Cables, Repeaters and Installers, driven by the customer, expanded this concept towards a broader approach.

The Junior System is an 8 (eight) Fiber Pairs system, connecting Rio de Janeiro (Praia da Macumba) to Santos (Praia Grande) in Brazil, as shown in Figure 1.

Figure 1: Junior System

The cable is 390 km long and uses 3 (three) repeaters as defined on the system design. Given the relatively short system length, a hybrid approach was used, with 6 (six) repeated fiber pairs, and 2 (two) unrepeated fiber pairs. This has provided the “best of two worlds” for this system, providing higher OSNR for the repeated fibers, with capability to support advanced modulations formats, and providing higher traffic capacity. On the other hand, the unrepeated fibers, despite the inherent lower traffic capacity, provide a higher system reliability which are typical of such systems.

However, a good system design & concepts is just the initial step for efficiently building a Subsea Cable System, and will require also good execution, with highly efficient project management, given all the challenges involved.

2. SYSTEM BUILDING

Submarine cables are not new to the market with first systems dating from the 1850’s, for carrying telegraph traffic. Since the 1980’s, optical cables started to be deployed and continue to evolve until the modern cables being currently deployed. This is a traditional and long-established industry, so having a new submarine optical repeater provider leading the Junior project as a turn key contractor was another bold point for this system.

As any subsea cable construction, one of the first key activities performed was the route marine survey. For the Junior System, the Marine Survey was contracted separately from the main installation provider, for the sake of efficiency and overall project cost. This was possible given the recent boom of new cables arriving in Brazil, which allowed the optimization of the survey activities in the region. However, this required even closer coordination of all involved parties, including the main marine installer, survey contractor, customer and turn key integrator contractor.

Figure 2: Repeater Assembly

Another project key point was the integration of the cables and repeaters within the Main Lay Vessel (MLV). Usually, the cable & repeaters integration is done on the cable manufacturing plant, before loading on the MLV. This makes perfect sense for large systems, which normally employs tens (or hundreds) of submarine repeaters. However, for shorter systems, such as the Junior System, this approach would add unwanted additional logistics complexities, days to the Plan of Work and increase costs. Given that, taking advantage of the Route Clearance period, the cable & repeaters integration was successfully executed on board of the MLV.

3. JUNIOR SYSTEM DESCRIPTION

3.1- Repeaters

As defined on ITU-T G.694.1, a Flexgrid Wavelength Selective Switch (WSS) allows 772 manageable slices of 6.25 GHz, in a full manageable spectrum width of 4.825 THz. The use of this spectrum can be realized in flexible ways. It is possible to work simultaneously with different channel spacing in integer multiples of 12.5 GHz.
The Optical Submarine Line Amplifier (OSLA) is a amplifier designed for advanced performance, with reduced dimensions and weight for simpler handling during assembly and laying. It is designed for transport of high performance DWDM transmission systems, with up to 130 traffic carrying channels at 100 Gbit/s using 37.5GHz spacing per fiber pair. The submarine repeater enables systems configurations from one up to eight fiber pairs with completely independent operations.
The submarine repeater development has been completed at the end of 2013 and the qualification of the repeater itself has been carried out in world recognized laboratories as in California and Texas, according to ITU-T recommendation G.976, and witnessed by a inspector of the ISCTI Certification Body. A sea trial was carried out in May 2014 in the the Caribbean Sea near Tortola (BVI), in shallow waters using Single Armoured (SA) cable, and in deep waters (>6000 m) using Light Weight (LW) cable.

3.2- Cables

All submarine cables deployed in the Junior System are armoured, Double Armoured (DA) and Single Armoured (SA) types, suitable for installation in shallow waters on the continental shelf, which are the case for the Junior System.

The submarine cables were manufactured at the cable provider facility in Europe (according to the final route engineering design), in 4 (four) segments plus one Pre-Lay Shore End (PLSE), land cables and spares.
All cables sections were factory audited and inspected.
The submarine sections were loaded to the Main Lay Vessel at the factory quay and tested again after loading.

The composite land cables and return ground cables were installed by turn key contractor in customer Out Side Plant (OSP) ducts, being the distance between Beach Manhole (BMH) and respective Cable Land Station (CLS) of approximately 4,5 km in Praia Grande and 12 Km in Praia da Macumba.

Main fiber characteristics:

Repeated fibers: G.652.D, att @1550nm < 0,19 dB/km;
Unrepeated fibers: G.654.D, att @1550nm < 0,17 dB/km;

3.3- Marine Services and Shore Ends

The Survey was performed by a third party under supervision of a joint team of turn key contractor and Marine Installer, assuring the right responsibility assignment for each party.

The main Marine Programme was performed by the CS Teliri MLV that transported the submarine cable sections, deploying and fully burying the system to 1m to 1,5m depth in the sea bottom, starting with an initial splice to the PLSE at Praia Grande and ending with a Direct Shore End (DSE) at Praia da Macumba.

Repeaters were manufactured in the turn key contractor factory in Brazil, integrated with the submarine cable segments and tested on board the Main Lay Vessel (MLV) during the (Pre Lay Grapnel Run) PLGR and Route Clearance (RC) phases, after the vessel arrival in Brazil.
The turn key contractor specialized team performed this task on board after a careful planning and training preparation, with all necessary equipment, instruments and tools on board of the MLV.

The full system was thoroughly tested on board by the turn key contractor after the integration and before the System deployment.

All of the repeated and unrepeated fibers were monitored during deployment with the repeated system powered by the MLV Power Feeding Equipment (PFE).

Several crossings with telecom cables and oil/gas pipelines were carefully performed, according to the agreed crossing conditions.

A reasonable amount of Post Lay Burial Inspection (PLBI) was also performed by the MLV at crossings and selected areas.

The Shore End at Praia Grande was performed with a 6 km PLSE DA cable section installed from the BMH using a local shallow water vessel equipped by the turn key contractor. Seaward ducts were previously installed from the BMH to a point near the Low Water Mark (LWM) at an average depth of 2 meters and allowing the crossing underneath the local sewage ducts about 5 m deep.

The Shore End at Praia da Macumba was performed from the BMH by the MLV and burial profile at the beach was deeper, down to 3 meters, in order to live with the high energy beach behaviour.

3.4- Power Feeding Equipment (PFE)

Each converter of the PFE, as well as the plant alarm and monitoring function, communicates with the remotely located Element Management System (EMS) through the Local Control Unit (LCU), to provide surveillance of the PFE. Plant voltage, plant current, converter status, alarm status, and shutdowns are all reported back to the EMS via the LCU. Each of the two converters, Converter 1 and Converter 2 in, contains power stages and associated control circuits to convert –48-volt input to high-voltage output.

Each converter contains a high voltage relay. This relay directs the high-voltage output of the associated converter to one of two connections: an internal plant high-voltage output or to the integral test load module. Each relay reports its position to its associated plant alarm and monitor function.

The following voltage and current parameters are monitored:

- PFE output voltage and current
- PFE return current
- Station ground current
- Ocean ground voltage
- Converter output voltage and current
- Current unbalance

The PFE system provides an integrated test load for the purpose of evaluating power converters and performing Power Soak testing prior to placing a converter on cable. The Test Load is programmable via the LCU and features functions emulating those found on the PFE output section, including current and voltage alarms and shutdowns, electroding, alarm centering and ramping.

3.5- Permits

The turn key contractor, as the Turn Key supplier for the Junior System, was also responsible for the timely issuance of all permits in principle and for the importation of foreign goods and services to the country, included the temporary admission of the MLV.

All the environment and navy licenses and procedures were also prepared by the turn key contractor and timely granted by local authorities, demanding particular focused efforts and contacts with those authorities.

Special care was necessary regarding the environment licensing process for cable lay on environmental protection areas (APA). Additional challenge includes the crossing of 2 (two) pipelines according with the procedures agreed previously with the pipeline owner.

Also, proactive previous actions regarding the MLV readiness for the entry inspections in Brasil were taken enabling the timely preparation for it and avoiding to lose project time during the vessel entry clearance. By doing that, the temporary importation of the vessel, required for such operations in Brazil, was performed with the release of the MLV for starting the operations in a extremely short period (less than 72 hours), which is a key for an efficient project execution.

4. KEY TAKEWAYS

Executing a project On-Time and On-budget is certainly a desired goal for any type of project. However, building a subsea cable, is probably in the top rank in terms of challenges for accomplishing such goals. For the Junior System, the bar was even higher since the turn key contractor was a new player on the submarine cable market.
The answer to that is always based on having the right technology and products, and also a good system design. However, a really efficient project management and coordination was also key on this project, since it involved a number of providers for the products and services, not to mention the required environmental and operational licenses.

This market has been operating for years on really verticalized models, with traditional providers offering the entire project scope, from the repeaters and cables to the MLV operations. However, the market now seems to be open to a different approach, with a really "Open Cable" approach, considering multiple companies for providing all the required products and services for building a subsea cable. In such scenario, a company taking the lead as the turn key integrator is key to guarantee an efficient project management for a successful execution,