A STANDARD SET OF TECHNICAL REQUIREMENTS FOR CABLE INSTALLATION CONTRACTS

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Abstract: Submarine cable systems continue to expand around the globe and offer an ever expanding telecommunications network for residential, commercial, and government use. For owners, technology improvements allow for greater carrying capacity and higher revenue streams. At the same time, significant advances in Submarine Cable Management Systems (SCMS) in commercial cable laying technology have allowed for a high degree of control and management of the cable touchdown conditions. These systems use sophisticated computer modeling to monitor in near-real time the cable bottom condition in the recent past and to predict the results of future cable and ship actions. The result is a major improvement in the installer's knowledge of the cable's condition on the seafloor and in his ability to predict and control cable touchdown conditions. In order for the cable system owners to take full advantage of advanced real time control systems, the technical specifications for cable installation contracts should be standardized.

1. SUBMARINE CABLE INSTALLATION

The goal of a submarine cable installation is to place a cable on the seafloor with the appropriate amount of tension, slack, position and other seabed conditions desired by the cable owner. The installer is responsible to lay the cable along a given path at a designated level of bottom slack, safely and in a minimum amount of time. While the installer can easily control the ship end of the cable, he is ultimately responsible for the other end on the seafloor. What happens with the cable between the ship and the seafloor is the major unknown in cable laying. No matter how simple or complex, all cable payout methods incorporate some way of describing the cable shape between the ship and the seafloor. The degree of success of failure is directly related to the ability to adequately compute cable touchdown positions.

For the past 50 years, many cable models have been developed based on an adaptation of steady-state cable principals developed by E.E. Zajac of Bell Labs in 1957 [1]. Zajac laid the foundation for steady-state cable physics and because his solutions were simple to understand and visualize (Figure 1: defined by the cable angle from the ship), they have been used by cable engineers for years. However, steady-state conditions usually occur less than 50% of the laying time. In steady-state, there are no changes with time: the seafloor is flat, the ship is on a steady course at a uniform speed, the cable payout is steady and the cable being deployed is uniform. Therefore, steady state models provide rough approximations of the cable condition on the seafloor during specific at-sea conditions, but cannot accommodate many dynamic conditions which normally occur during cable installations. The ship speed often varies, cable payout is not always steady, the course is not always straight, and the cable catenary often contains sensors, repeaters, and splices. An accurate model that can handle unsteady solutions is therefore needed for much of the cable lay.

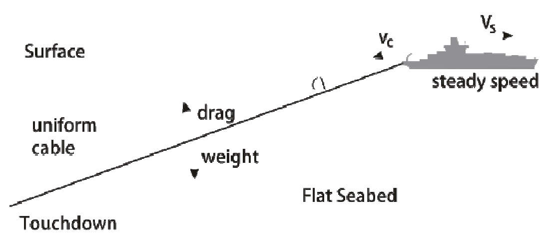

Figure 1: Steady-state solutions are easily visualized.

Advances in technology have shifted the cable installation focus from using steady-state models and ship (surface) slack control to using sophisticated Submarine Cable Management Systems (SCMS) that model bottom cable conditions. These systems use complex computer modeling to monitor, in near-real time, the cable bottom conditions in the recent past and predict the results of future cable and ship actions.

For the installer, the result is a major improvement in the installer's knowledge of the cable's condition on the seafloor and in his ability to predict and control cable touchdown conditions.

For the owner, accurate cable placement and control of bottom slack (or tension) increase the life of the cable and allow for more efficient and safe recovery and repair operations during failures.

Improper or inaccurate installation can lead to excess cable waste, shorten the life of the cable and lead to future maintenance problems which result in a loss of revenue.

In order for the cable system owners to take full advantage of advanced real time control systems, the technical specifications for cable installation contracts should be standardized.

2. STANDARDIZED CONTRACT TECHNICAL REQUIREMENTS

The submarine telecommunication industry, through the SubOptic Interim Activities Work Group (IAWG) has been working on a model contract with guidelines for the construction a submarine cable system.

In order for the industry and individual cable system owners to take advantage of today's proven technology in advanced submarine cable management systems, a standard set of technical requirements should be established describing what a submarine cable management system should have in order for consistency in high quality installations.

3. TECHNICAL REQUIREMENTS FOR A SUBMARINE CABLE MANANAGEMENT SYSEM

The installer should be required to utilize a comprehensive computerized Submarine Cable Management System (SCMS) during the installation of the submarine cable. This system should have the ability to incorporate near-real time input data from the ship positioning equipment, cable engines, ship gyro, plow, and ROV and compute the cable touchdown conditions in near-real time under any ship maneuver or cable payout situation whether planned or unplanned. The system should be able to log all incoming and computed data and provide a highly accurate record of the as-laid cable's position and bottom tension or slack along the path and, preferable, in a GIS format. The SCMS should also be able to regulate cable payout and/or ship speed to control cable slack on the seafloor. To accommodate these needs, the following features should be required:

Monitoring Capabilities:

An essential part of the SCMS should be a real-time, rigorous, 3-D, dynamic modeling of the cable in suspension to provide accurate cable touchdown positions and bottom slack or bottom cable tension.

The cable model within the SCMS should have the ability to accurately model all significant factors affecting the cable dynamics, including full 3-D modeling, complex cables and shapes that change with time, numerous cable types and cable bodies which can be simultaneously in the water column.

The SCMS should be able to compute and dynamically-correct cable shapes under the following conditions:

- When placing a cable with slack on the seafloor
- When placing a cable with tension on the seafloor
- When deploying in-line cable bodies on a cable with bottom slack or tension
- When stopping and restarting a cable lay
- When recovering a cable

For quality assurance, the SCMS software should have been thoroughly tested, calibrated, and validated with at-sea trials and shown to provide accurate predictions of cable touchdown conditions. Validations shall have been completed with Long Base Acoustic Navigation Systems that demonstrate the cable (and attached in-line bodies) has touchdown coordinates as predicted by the 3D dynamic model within the monitoring system.

The SCMS should have the option to incorporate real-time measurements of ocean currents in the modeling of the dynamic shape of the cable in suspension to improve the predictions of touchdown conditions and seafloor slack.

The SCMS should be suitable to monitor the cable touchdown conditions during recovery operations and be able to model cable dragging on the bottom when the cable is subjected to bottom tension.

Seafloor Slack Control

The SCMS software should use 3-D dynamic monitoring algorithms to predict the near-future cable shapes, touchdown and slack conditions. It should also compute the appropriate cable payout speed in order to achieve the desired seafloor cable slack.

The SCMS should integrate with the vessel systems and display cable forecasts by numerically and graphically displaying the future cable touchdown conditions and graphs of future bottom slack, surface slack, ship speed, payout speed, and surface tension (Figure 2). [2]

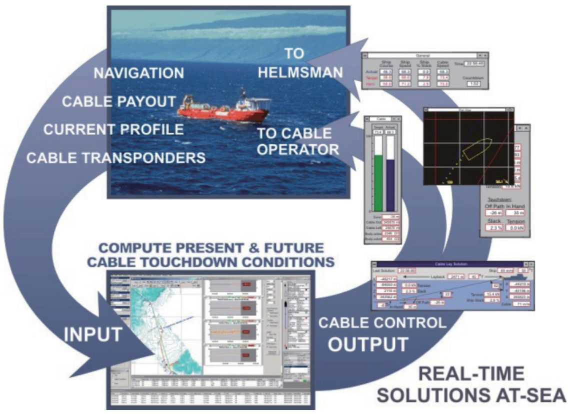

Figure 2: The SCMS must fully integrate with vessel systems and provide graphic and numeric cable control output to the helmsman and cable operator.

Navigation and Ship Guidance:

The SCMS needs the capability to provide instructions to the cable ship for following the designated Route Positioning System (RPL) at the designated ship speed and to provide graphical guidance for the vessel along the pre-planned route. It should also display, numerically, the ship's position, speed, course, offsets from the desired ship's location, and the current and future instructions to the ship.

The SCMS should also have the capability of providing instructions digitally (e.g., RS232, RS422 or via network) to the ship's dynamic positioning system. Instructions should include waypoints and ship speed. The operator must be able to update the instructions at any time.

Date Input & Logging:

The SCMS needs to log in real-time all data pertinent to the lay – including GPS positioning, gyro, cable payout, plow positioning and depth, ROV positioning, etc. All data should have a time stamp and be logged and accessible in the system.

The operator should have access to all logged data, for display, graphing and reports.

Key events need to be logged, together with comments and notes on those events, in a database which includes search and sorting routines.

The SCMS needs to store all computed cable shapes, dynamics, and touchdown conditions for each solution generated. Archival data must be sufficiently complete, so that an accurate recreation of the entire lay can be performed in a post-lay analysis. As a minimum, archival data should include: all program input data, all cable solutions and all ship and cable payout instructions.

The monitoring software should store a complete record of touchdown locations and slack/tension conditions for the cable along the complete path. The log should also be in a GIS format suitable for direct access by any GIS software.

Access to Data:

SCMS displays should be available at key locations throughout the ship. The displays should have the capability to be individually customized.

The SCMS should also provide a remote display for the owner's representative onboard where near-real time cable shapes and touchdown data are available at all times during lay operations and access is provided to historical data and the events log.

Backup and Redundancy:

The SCMS should include on-line backups for all critical computer components and a means of quickly switching from one computer to the other without disrupting the cable lay or management of that lay.

4. CONCLUSION

The submarine telecommunications industry has been diligently working on developing a recognized standard set of fair and balanced contract terms for contractors. High technology Submarine Cable Management Systems provide cable installers with knowledge of the cable's condition on the seafloor and the ability to predict and control cable touchdown conditions with a high degree of accuracy. These systems have been successfully demonstrated during the last decade. In order for the cable system owners to take full advantage of advanced real time control systems, the technical specifications for a submarine cable management system should be included as part of any recognized set of requirements for cable installation contracts.

5. REFERENCES

[1] Zajac, E. E., *Dynamics and Kinematics of the Laying and Recovery of Submarine Cable*, Bell System Technical Journal, Vol XXXVI, No. 5, September 1957

[2] Andres, J.M., *Recent Advances in Submarine Cable Deployment Technology and Their Importance to the Owner and Installers*, Third Annual Fiberoptic Submarine Systems Symposium, Hong Kong, June 9-11, 1996.