

Innovative Electrical Optical Flying Leads Help Ocean Networks Canada

Providing Reliable Power and Communications
7800 Feet Down on the Ocean Floor—for Years at a Time

Background

Ocean Networks Canada (ONC), an initiative by the University of Victoria in British Columbia, Canada, operates and maintains world-class cabled ocean observatories that offer continuous power and communications capabilities to their users. These observatories enable hundreds of scientists around the world to initiate all types of seabed-based research and receive continuous streams of data at their locations in real-time. Enabling sensitive instruments such as pressure recorders, acoustic Doppler profilers, underwater cameras, hydrophones, seismometers, and sensors of all kinds to be literally “plugged-in,” right on the ocean floor, ONC observatories allow the collection of data on physical, chemical, biological and geological aspects of the ocean over long periods of time, supporting research on complex Earth processes and sea life in ways not previously possible. Research underway includes deep water studies related to earthquakes, tides, tsunami formation, biodiversity, hydrothermal vents, ocean sounds, water quality, marine organisms, gas hydrates and much more. The instruments collect more than 200 gigabytes of data every day, all of which is freely available to researchers and the public through the ONC website at <http://www.oceannetworks.ca>. ONC’s largest observatory—the North East Pacific Time-series Underwater Networked Experiments (NEPTUNE) network—is a 500-mile loop off the west coast of British Columbia, with two instrument groupings located at depths of more than 7800 feet.

Interconnect

Product:
Electrical Optical Flying Lead (EOFL)

Application:
Cabled Ocean Observatory

Client:
Ocean Networks Canada



Initial NEPTUNE concept — napkin drawing by scientists over dinner

Credit: Ocean Networks Canada

Challenge

According to Ian Kulin, ONC Director of Marine Operations, the genesis of what would become Ocean Networks Canada observatories such as NEPTUNE began as a drawing on a cocktail napkin created by a group of scientists over dinner one evening in the late 1990s. However, moving from serviette to full service proved to be a daunting task.

“Subsea work is very challenging,” said Kulin. “In many ways it’s easier to operate in outer space. Space is actually a lot more forgiving than the hostile environment at the bottom of the ocean.”

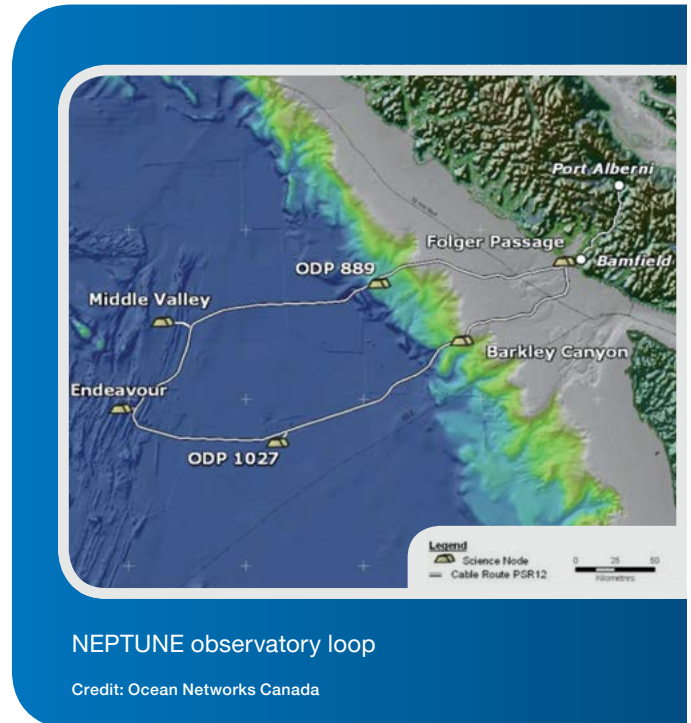
In addition to the constant crushing pressures, he explained, equipment must stand up to continuous cold — sometimes interspersed with superheated water rising from nearby vents — as well as razor sharp rocks, damage from sea life and trawling, corrosive forces and more. In addition, because the area is inaccessible to humans, set-up must be done remotely using sophisticated robotics controlled remotely from the surface.

These challenges, he noted, were further compounded by the group’s longevity goals. Previously, deep-sea networks had been designed to operate on an ad hoc basis — for weeks, months or maybe a year. Nevertheless, ONC’s goal was to keep their observatory operating for 20 years or more.

“This had never been done before,” he said. “ONC needed a sophisticated solution to not only meet these challenges, but do so for the long term,” he said.

According to Kulin, early attempts to develop robust cable solutions were marred by equipment failures; cables suffered electrical, fiber, and in some cases structural failures. A relationship with one firm quickly soured when some of their highly touted pieces of equipment “imploded” in use.

“These observatories are very expensive to deploy and maintain — we estimate an investment of \$1 every second,” he explained. “That’s one thing when the system is working as intended, but when equipment fails and the system is down, it’s a waste of precious time and resources. Not to mention, we have to go and pull all that stuff back up.”



Highlights:

- Twenty-year life span in challenging underwater conditions
- Reliable equipment increases operational up-time when failures are costly (\$1/second)
- Teledyne’s networked solution included ‘meticulous’ design and testing to validate reliability
- System has been operational with no issues for more than two years

Solution

After these costly failures, ONC turned to Teledyne ODI, for, as Kulin noted, “an engineered solution with a proven track record.” Teledyne designed and constructed a custom-configured system featuring a set of four electrical-to-optical-to-electrical flying leads in order to transmit data from the instruments and provide power in a small footprint. The EOFL converts a fiber optic signal through a fiber optic wet-mate connector, and produces an electrical Ethernet signal through an electrical connector on the other end. This patented technology allows data to be transmitted through deep water at distances far greater than previously possible, with little to no signal degradation. The conversion from optical to electrical is accomplished in a compact, 1-atmosphere internal pressure chamber that is rated up to 10,000 PSI. The cables form a 500-mile dual loop, with both power and communications flowing in both directions, providing automatic backup redundancy. The entire system is modular so that portions can be moved or surfaced as needed, and some areas are armored to provide additional protection against the hazards of the ocean bottom.

The Teledyne system features several other innovations designed to creatively solve the special challenges of the application. One of Kulin’s personal favorites are the pressure-balanced oil-filled hoses.

“The way the fiber mates with the connector is very innovative — brilliant actually,” he said. “The electrical connection is in an oil-filled bladder that seals itself even as the equipment is moved around on the sea floor.”

Results

But perhaps the greatest innovation Teledyne produced, Kulin says, is reliability. The difference between the Teledyne ODI system and anything ONC has tried before is night and day.

“It is functioning perfectly. It’s been in constant use for nearly two years, with plugs mating and unmating thousands of times, and there hasn’t been a single failure due to their equipment,” he said. “With Teledyne, we can finally be confident that the power and the communications capabilities will be there when we need them.”

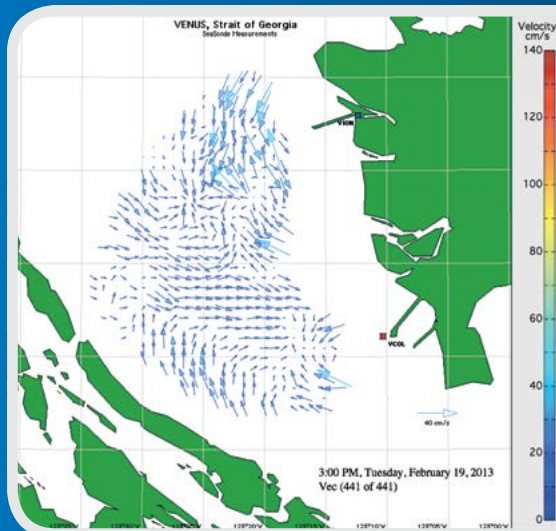
Part of Teledyne’s high reliability, Kulin believes, is due to their insistence on a scrupulous testing regimen.

“A big frustration in this kind of work is that things might operate fine at the surface, not work at all on the ocean floor, and then, when you bring them back up, work fine again,” he explained. “Teledyne runs their equipment through a wide variety of tests at the factory that others can’t or won’t do — pressure, temperature, vibration and more — before they deliver it to us. That provides a high degree of surety that it will work under the conditions it is intended to. And it has.”

Teledyne ODI

Products & Services:

- Electrical & Optical Wet-mate Interconnect Systems
- High Power Interface Solutions
- Subsea Distribution Systems
- New Product Development
- Cable Terminations



NEPTUNE observatory data

Credit: Ocean Networks Canada



Electrical Optical Flying Lead

Credit: Ocean Networks Canada

Kulin is also impressed by Teledyne's willingness to work with ONC to continually improve designs and add capabilities.

"They are very open to whatever ideas we throw out there," he said. "And, they have the brain trust to figure out how to do it, even if it's something that has never been done before."

Working together, ONC and Teledyne are planning to expand the system and lay two more cables in 2019.

"Teledyne is definitely our go-to for these types of solutions," said Kulin. "We work hard to maintain our position as a global leader in cabled observatories, and Teledyne is not just a partner, they are part of ONC at every level and a key technical supporter of our mission."

Meanwhile, NEPTUNE keeps on operating successfully, with ONC planning to deploy new experiments in the summer, including some innovative research on solar neutrinos. And, Kulin says, he expects his team to be serving the scientific community with new deployments for many years to come.

"We came to Teledyne asking for a 20-year design," he said. "But seeing it in action, and seeing how knowledgeable and meticulous they are, I have to believe it will be good for 40."

Member of:



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