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Multiplexers and Telemetry Solutions for Underwater Tech

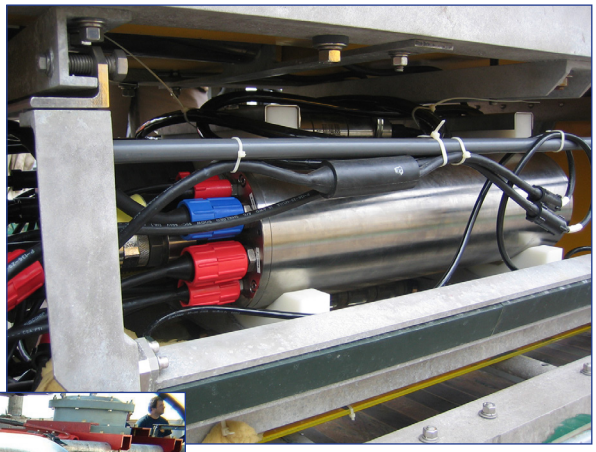
NEXUS Range Ensures High Data Transmission

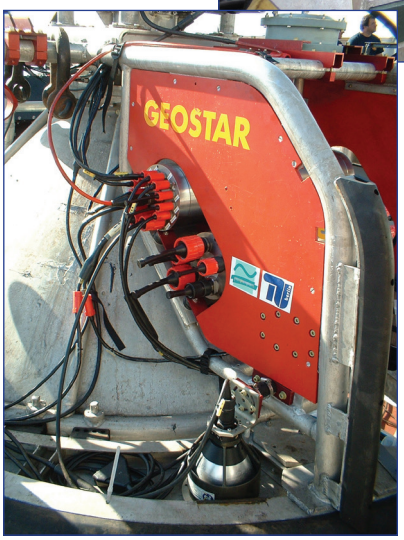
By Jes Højlund • Dr. Ole Aarup Mikkelsen

With the development of more demanding sensor suites, the requirement for reliable transmission of large amounts of data and video from ROVs, ROTVs, ocean observatories and instrumentation packages increases.

To meet this need, the MacArtney Group has developed the NEXUS plug-and-play range of telemetry systems that operate as fully transparent fiber-optic interfaces between subsea data and video collection units and topside and shore-based control and data presentation. A version with electric interface enables data and video transmission over 6,000 m of coax cable.

The NEXUS multiplexer range has been developed in close cooperation with our customers and forms the backbone of many multiplexing systems installed around the world.





(Top) MacArtney's NEXUS multiplexer range forms the backbone of many multiplexing systems installed around the world. (Bottom) The very first NEXUS MK I was used on a MODUS vehicle for deployment of an underwater observatory.

Multiplexing

A multiplexer, or mux, is a telemetry system that interfaces multiple real-time electrical signals between subsea units and surface control, typically by means of fiber optics. The NEXUS range is powered by Moog Focal multiplexer boards.

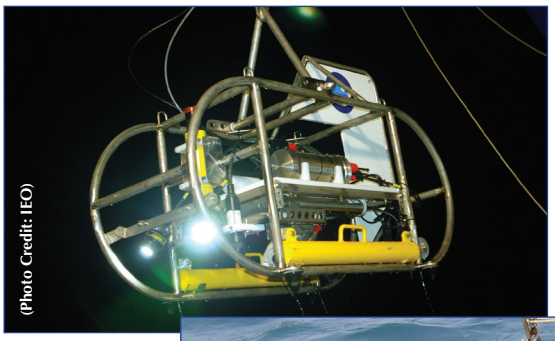
During the last two decades, MacArtney has built up a strong and versatile track record of supplying in-house developed and manufactured NEXUS multiplexers and complete NEXUS telemetry solutions to OEMs, system providers and operators on a global scale.

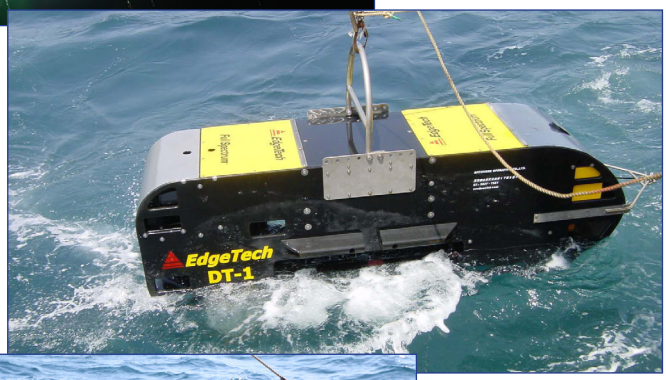
Providing the link between surface and seabed, NEXUS multiplexers bring together Focal multiplexer cards and other state-of-the-art telemetric technologies and are widely used for subsea applications such as ROVs, trenchers, towed monitoring systems, ocean observatories and other sensor carrying systems. Beyond interfacing a vast variety of sensors mounted on board a vehicle, CTD or other sensor platforms, NEXUS multiplexers work to provide and sustain a safe and efficient fiber-optic or electric link between surface and seabed. Standard connectivity interfaces on NEXUS telemetry systems include SubConn and OptoLink connectors.

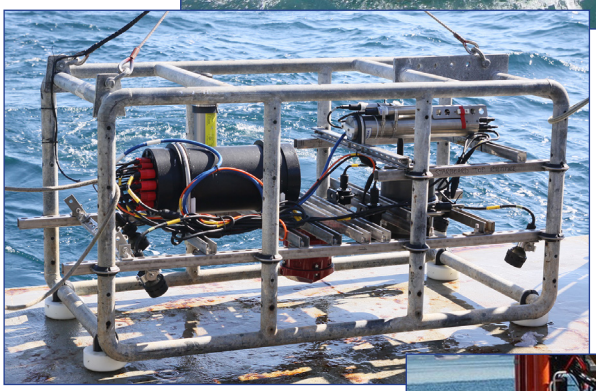
The NEXUS range includes several standard models spanning from advanced fiber-optic and HD-video capable systems to electric coax cable-compliant multiplexers to bespoke customer-specified or completely customized telemetry solutions.

First NEXUS

The very first NEXUS system was used on the docking module for the 1995 to 1998 EU MAST-III project Geostar (GEophysical and Oceanographic STation for Abyssal Research), which aimed to develop an innovative deep-sea benthic observatory for long-term scientific observations







(Top to Bottom) The MK E allowed the Spanish Institute of Oceanography (IEO) to transmit data and video through the existing coax cable mounted on the vessel's launch and recovery system. NEXUS MK VI systems are used on several deep-tow sonar systems during SAR operations, including that for Malaysian Airlines MH370. NEXUS MK C on MILET toolsled supporting a USBL-navigated video and SLR camera platform for benthic surveys, with effective operating depths of 2,500 m. IKM Subsea Merlin work-class ROV provided with NEXUS MK C multiplexers comprising complete topside units installed into 19-in. rack boxes with diagnostics on both LED levels and an extensive GUI for systems health data, a TMS stack, and an ROV stack.

at abyssal depths. After that project, the development of the NEXUS multiplexers began in earnest in 1999 after having been suggested by the multibeam echosounder manufacturer Reson.

NEXUS MK I

In the late 1990s, there was a trend in the market for ROV pipeline surveys to replace the dual-head-scanning profilers with multibeam sonar systems in order to increase survey speed, data quality and accuracy. However, the multibeam sonar systems required transmission of a much higher amount of ROV sonar data, and with the long umbilicals this could only be done via fiber-optic telemetry. Together with sonar data the survey crew also typically needed data sets from gyros, MRUs, sound velocity sensors, DVLs and depth sensors. Reson experienced that very often mobilization of their multibeam sonar systems on the ROVs was delayed because the interfacing of the typical two sonar heads plus the additional sensors was a bigger task than expected.

Based on the experience from the Geostar project, the NEXUS MK I system was developed to make this task much easier. It just required one extra fiber in the ROV umbilical and 110 to 240 VAC power supply to the NEXUS subsea electronics bottle and harness cables to be connected between the NEXUS bottle and the different sensors and sonar heads. A fiber-optic cable connection between the bottle and the umbilical J-box was also required to make the data available topside on the rear side of a 19-in. rack mount unit. The system was a fully transparent data telemetry system, with delay only equivalent to the minor delay in the fiber.

NEXUS MK II

The NEXUS MK II was a drawing board model only and never came into production. It would have been a multiplexer system only controlling two sonar heads and transmitting their data to the surface.

NEXUS MK III

Developed in the year 2000, the NEXUS MK III is very simple and comprises a dual (P)ECL board or two GbE boards to be connected in the ROV electronics pod. Topside, a similar set of boards are delivered in a 19-in. rack mount unit. If the sonar heads require separate RS232/485 control, this must be handled via the existing ROV multiplexer.

NEXUS MK X

In 2001, the bigger NEXUS MK X was developed. This system comprised a much bigger electronics bottle and a topside with room for the Focal 903 type multiplexer. Remote and console 903 boards were Eurocard size, hence the requirement for a larger ID of the electronics bottle. The interface of video cameras was also included, with eight video channels, up to 32 serial, plus the (P)ECL and Ethernet signals. The flange of the pressure vessel could not accommodate the large number of connectors. Therefore, two oil-compensated J-boxes were connected with the electronics bottle via multipin connectors. The individual sensors and cameras could then connect their harness cable to the dedicated connector on the J-box.

A couple of the NEXUS MK X systems were also fitted with a small touch screen topside for camera and pan/

tilt control. The biggest customer was Thales Geosolutions (later Fugro), which used the multiplexer on their first FCV3000 ROVs.

NEXUS MK V

In 2004, one of our large customers asked for a Nexus MK I-size multiplexer fitted with a couple of video interfaces. At the same time, Focal introduced the new mux board 907 based on a PC104 form factor PCB. MacArtney developed the NEXUS 907, which was later renamed NEXUS MK V and had the MB sonar interface included. EMGS Norway is a major customer of this model.

NEXUS MK IV

In 2007, the NEXUS MK I had a major upgrade and was named Nexus MK IV. In 2009, we changed the configuration to meet the requirements from rental companies. This meant that the same multiplexer could connect to a dual MB sonar setup, both the older type with (P)ECL interface and the new ones with Gb-Ethernet. Power supplies were prepared for both types, so it was just a matter of using the right harness cable and then changing the settings in the INI files in the software.

This NEXUS was now called NEXUS MK IV (second generation). It is used as an add-on plug-and-play telemetry system together with MBES and many different survey sensors.

NEXUS MK E

For many years, customers from the ocean science community had asked for a multiplexer that could be used together with their existing CTD cables, often up to a length of 8,000 m on big winches. They could not afford to switch to electro/optical cables and include fiber-optic-rotary-joint with the slip ring on the winch, but they wanted connection to additional sensors together with their existing CTD system or custom-developed instrumentation packages.

With the NEXUS MK E launched in 2010, they got the possibility of connecting one video camera, eight serial channels and one low-bandwidth Ethernet, transmitting data over 6,000 to 10,000 m coax cable. LED light control is also possible, and if the customer subsequently wants to upgrade to fiber-optic telemetry, an OptoLink connector can be installed in the flange. These systems are used, for example, in ocean science studies down to 6,000 m depth. The typical application for the NEXUS MK E is to interface a camera and light with CTD equipment in a drop camera, tow sledge or CTD rosette package.

NEXUS MK VI

With the introduction of HD underwater cameras for ROV pipeline surveys, the MacArtney offices in Stavanger, Aberdeen and Houston were often asked for the possibility to add a 3x HD camera interface to the NEXUS MK IV. One model was made with an add-on camera pod, but MacArtney soon realized that in order to sell this product it had to be plug and play. Thanks to the new Focal 907 flex board a new NEXUS system was therefore designed.

In 2013, the NEXUS MK VI was released, offering the interfacing of HD video cameras together with the dual-head MB sonar head operation. Within just two years, 11 NEXUS MK VI systems have been sold. The NEXUS MK VI systems have been used on several deep-tow sonar systems during SAR (search and rescue) operations, including the search for Malaysian Airlines MH370.

NEXUS MK C

MacArtney has also been making several customized multiplexer solutions involving the NEXUS MK C. One example was used in the Gulf of Mexico in 2010.

In April 2010, 80 km offshore and 1.5 km below the surface of the Gulf of Mexico, an explosive blowout underneath the BP rig *Deepwater Horizon* caused the most disastrous oceanic oil spill in the history of subsea drilling. For several months, authorities battled the enormous quantity of crude oil that would eventually affect the ecosystem and economy of the entire Gulf region.

Biological oceanographer Dr. Ian MacDonald and his colleagues at Florida State University (FSU) and the Florida Institute of Oceanography (FIO) researched and analyzed the spill impact on life in the deep-sea realm of the Gulf of Mexico. Understanding these impacts is crucial for charting the Gulf's recovery and preparing for future accidents.

As part of their toolkit, FSU assembled the MILET (Modular Instrument Lander and Equipment Toolsled) deep-sea imaging system. Originally developed to expand the frontiers of deep-sea biochemistry and benthic image surveying in underexplored regions of the Gulf, the flexible MILET instrumentation system can be used on a wide array of vessels and can carry the latest camera, sonar and sensor technology. The toolsled is empowered by a winch and telemetry system solution supplied by MacArtney. The telemetry part of the system comprises a built-to-order, plug-and-play NEXUS MK C multiplexer, or "mega mux" due to its vast number of connectivity and instrumentation options.

The advent of high-resolution digital cameras, high-bandwidth data exchange and improved acoustic navigation, all interfaced by the NEXUS MK C multiplexer, makes the use of a lowered deep-sea imaging system more efficient and powerful, giving scientists immediate access to high-quality results to visualize the consequences of disaster.

NEXUS MK VII

A more modular multiplexer was developed in 2015, the NEXUS MK VII. Its configuration changed simply by adding or removing circuit boards and changing the wiring.

The NEXUS MK VII is highly configurable and allows for an easy upgrade/modification path when operational or when application requirements change. Multiplexer options can be installed between jobs or even at sea without the need for an electronics workshop.

As a standard, all the NEXUS multiplexers subsea housings are manufactured from hard anodized aluminium, and from titanium for 6,000-m versions. Connectivity interfaces include SubConn anodized aluminium connectors, SubConn Coax (HD video) connectors and a MacArtney OptoLink fiber-optic connector.

Conclusion

Gathering high-quality data from the abyss is an immense undertaking that requires ensuring that multiple sensor and equipment types work in perfect unison and

that all data are efficiently transmitted to the surface for analysis.

Together with MacArtney's highly versatile data acquisition solutions, the NEXUS multiplexers and telemetry systems have demonstrated proven performance and come with support provided by MacArtney teams with specialist knowledge and expertise. **ST**

Jes Højlund is a system sales manager with the MacArtney Group with significant experience in the underwater industry. His focus is on the sales of telemetry systems, sonar equipment and camera/light products. He has a master's from Fanø Nautical School and has held previous positions in the merchant navy and Svitzer Survey & Diving.

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