SCIENTIFIC APPLICATIONS FOR TELECOMMUNICATIONS TECHNOLOGY

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1 INTRODUCTION

For decades companies have been constructing undersea communications networks to support the telecommunications industry. New markets, specifically the scientific community, have emerged recently that are leveraging this technology to build new, large telecom infrastructures. This paper will identify these markets and discuss how the hardware and techniques are being implemented in these markets to support these endeavors.

2 THE OCEAN OBSERVATORY

It has become more common for many organizations that have a stake in education and private enterprise to contribute to fostering the development of breaking new ground in undersea exploration. For example, the National Science Foundation (NSF) is often described as one of these organizations that has been a primary financial sponsor of oceanographic research for many years.

It stands to reason that the current educational research, as well as future research plans, should call for aggressive funding of scientific observatories to help facilitate oceanographic research. The development of these networks and observatories enables scientists to better understand undersea activity and its impact on the environment and civilization as a whole.

The oceans contain hidden pieces of information that could impact the way we think about the atmosphere, climate and earth processes. For years scientists and oceanographers have been trying to develop ways to tap into this information, leading scientists to develop the “observatory” approach. Essentially, observatories are large research sites that are picked for their vast amount of unexplored information that are available for scientific review.

These observatories are chosen to enable the scientist to observe and conduct experiments on the entire water column. These experiments are executed by installing a fiber optic cable that will support the real time two-way data transfer that is required for constant study of the entire landscape. The systems allow for additional specific and fixed mobile experiments. This observatory approach creates fodder for multiple studies of interrelated topics. The contents garnered will be examined, looking for further proof from the oceans of its impact on the atmosphere and earth.

The question remains how are observatories developed and what is the best way to harness the data that is gathered and relay it back to land based scientists who can evaluate the information.

3 INTEGRATING TELECOMMUNICATIONS TECHNOLOGY INTO NEW MARKETS

In the past, utilizing undersea telecommunications equipment for underwater observation was considered too costly and cumbersome. The science community could not afford the state-of-the-art equipment, such as fiber optic cable components or the repeaters for the wet plant portion of the system. The systems also required the dry plant equipment, which includes the means to power the cable and the electronics that actually play a part in transforming the optical signal to voice or data. The system will then send on the information to the end user.

When the telecommunications bubble burst in the time between 2001 and 2002, it resulted in the opening of markets that were previously not considered. A few of the newly identified markets included Science and Oil and Gas. As a result of this realignment in the industry, the science and oil and gas industries were able to leverage their interests with the technology available and take advantage of the opportunities to support ocean observatories and oil and gas rigs in the field. This has opened the door to once unthinkable opportunities within these communities. This technology allows users to build science observatories as well as develop techniques to support the oil and gas industry during weather related events.

For years ships have been deployed and used as floating computer centers and high technology laboratories. However, this is very costly due to the high costs for fuel, ship maintenance and day rental rates. Another limitation of deploying ships for data retrieval is that the ships are only on station a short time, versus being able to capture data over long periods of time. Continuous data collection over long periods of time allows trends to be observed which may be missed in short collections of data. In order to drive the collection of reliable information in real-time, equipment was identified that could support the transmission of continuous two way data. This requires the implementation of large amounts of bandwidth and the development of an ample power supply to support these state-of-the-art scientific investigations.

The equipment that is currently being used to gather data from the oceans and on the ocean floor is extremely effective. The challenge, until recently, has been to determine the most effective way to transmission the gathered information back to the scientists. Once the scientists can access the information, it will be analyzed, evaluated and either a conclusion will be drawn or the scientists will determine that more information is required for their analysis.

These network observatories utilize scientific nodes placed on the seabed or in the water column to monitor sub-sea activity including tectonic plate movement, microbes discharging from hot vents, sub sea currents, air-sea interactions, biologic migration in the water column and many other processes. Through scientific observatory advancements, the network observatories have requested assistance from the undersea telecommunications community. The providers are asked to design, manufacture and install cables, nodes and hardware to support ongoing research and development initiatives.

4 TELECOMMUNICATIONS EQUIPMENT FOR UNDERWATER OBSERVATORIES

Historically communication between areas of scientific interest and the scientist has been delivered through the implementation of satellite methods. Using buoys to retrieve information from sensors and scientific nodes, information would be transferred back to the research teams on the ground. This is a slow and sometimes risky challenge due to uncontrollable weather events that can delay transmission and result in the loss of important information.

This challenge is assuaged by utilizing undersea cable technology to bring the information back to researchers on land. The cable can be laid on the ocean floor for thousands of kilometers without the risk of weather delays or loss of transmission. However, there are risks associated with undersea cable. As we have seen recently, undersea earthquakes can threaten the cable, as with the recent earthquake off of South East Asia that caused some major disruptions of cable systems.

When evaluating a site for an undersea observatory, the first step that needs to be taken is a desk top study. This study helps to determine the preliminary route of the cable and the location of the observatory. Factors that could not be identified without the survey, such as underwater vents and faults, are noted during the desk top study. The teams will then anticipate these breaks in the terrain, leading the builders of the observatories to choose another route.

Once the desk top study is completed, a marine survey is executed to video the area and plot the route. This survey is also looking for any undersea anomalies that would need to be avoided. The cable type and planning aspects, such as burial of cable to avoid external aggression, are all derived from the marine survey.

The marine survey is a critical component of the overall program. The location of the observatory, the path the cable approaches the observatory, and the route the cable follows from land and between observatories must be examined. It is imperative that marine surveys identify undersea mountains and crevasses that will require a work around to provide a robust long term solution to the customer. If a cable is laid down in an area that will make it difficult to service or cause possible problems with external aggression, this could put the entire observatory at risk.

Once the marine survey is agreed on then the manufacture of the equipment begins. This includes the wet plant equipment which is primarily made up of cable and the undersea amplifiers, repeaters. The next step is to build the dry plant, which is located in a building on dry land and is the location for cable landings.

Another piece of equipment in the system is the Branching Unit. Branching Units are built similar to repeaters and allow for the observatory to cover more ground with the junction boxes to sample a larger field. This equipment powers the cable and provides the necessary electronics to send the signals down the fiber optic fibers that are embedded in the cable.

Building the rest of the ocean observatory requires additional pieces of telecommunications equipment for data transmission and networking, as previously highlighted. The equipment needed includes the actual undersea fiber optic cable and junction boxes. The junction boxes are connected to the fiber optic backbone, which will support each component with power and communications connectivity. Two primary functions include simple two-way communication, between the experiments and shore and between related experiments, and real time video documentation of undersea experiments.

The fiber optic cable capacity and bandwidth is scalable, so it can support additional applications required by these observatories. ROVs connected to the ship are used to re-deploy assets in the observatory while gliders are often attached by tether to the junction boxes to increase the scope of sampling and set off to explore the ocean floors. These gliders and equipment are generally attached with a tether that provides the power and fiber optic connectivity which allows for data retrieval.

5 UTILIZING CABLE SHIPS, ROVS AND PLOWS FOR SCIENTIFIC OBSERVATORY DEVELOPMENT

Cable ships, ROVs and plows are routinely used in commercial telecommunications industry to install, upgrade and maintain networks. The scientific community has been able to leverage this experience and utilize the fleet to upgrade and maintain the scientific networks as a cost-effective solution.

The ships are integral to the installation and maintenance of scientific networks. The ships are specifically built for the cable installation business, and are outfitted with three cable tanks to hold up to 5,000km of cable. The ships have cable engines, which are designed to assist in the outlay of the cable, applying the proper amount of slack to ensure the cable does not become entangled. The ships also employ A-frame cranes, which assist in the deployment of the ROVs, sea plows and other equipment that supports the installation or maintenance of a cable. The combination of the ships dynamic positioning and cable handling capabilities allows for the precise placement of the science nodes and the cable leading to the science node through the area of scientific interest.

The ships assist in the deployment of the scientific arrays and nodes that need to be delivered to the sea bed. These arrays tend to be large and often awkward, so they require custom equipment to deploy them without the worry of costly damages to the gear. The ROVs deliver and place the equipment, ensuring the cable and arrays are properly connected to the power nodes. The sea plows ensure that the cable is buried at the proper depth so external aggression does not play into damaging the cable.

Telecommunications companies offer the scientific community the use of research and development labs to design and test the new products that support the infrastructure needed for a successful undersea network. This includes network designs and cable system architectures. These are necessary to support the communication and bandwidth, power distribution to sensors and equipment on the sea bed, interfaces to land based data management systems and internet, and the reliability required of these systems.

6 POWERING THE SCIENTIFIC NETWORKS

Undersea scientific networks do pose a challenge in the undersea telecommunications industry – how does a provider deliver power to the specific nodes on the bottom of the sea? Research and development engineers have developed a solution that delivers power through dynamical allocation based on predetermined priorities and reservations. This is critical for the various experiments that are being conducted.

The power must be easily accessed through tethers attached to a wet mate connector. These tethers carry the power to the end source – an ROV or a fixed site box that is monitoring current flow. These nodes are designed to provide live video and other experimental results back to land based scientists where the data is evaluated.

Wet mate connectors, a great innovation for undersea applications, allow the cables to be connected to junction boxes. This provides the equipment with power and communication. Wet mate connectors supply enough power through the tethers to power gliders and the other equipment to the areas that require are of interest. Once the boxes and cable are moved to appropriate areas, the cables are wet-mated to the junction boxes. Once this takes place, the scientists can review the data and evaluate if the systems are performing properly.

7 CONCLUSION

The telecommunications industry is taking an active stance in supporting and building undersea fiber optic networks in new markets. By leveraging the resources that the provider companies posses – from research and development, manufacturing, testing and deployment – the science community is empowered to stretch their limits and open their minds to harness the information the oceans have to offer.