PRACTICAL THOUGHTS ON USE OF SUBMARINE COMMUNICATIONS CABLES FOR CLIMATE MONITORING AND DISASTER WARNING – LESSONS FROM JAPAN'S EXPERIENCE

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Abstract: A joint task force to investigate the potential of using submarine telecommunications cables for ocean and climate monitoring and disaster warning has been set up by the United Nations organizations and agencies such as the International Telecommunications Union (ITU), the Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organization (UNESCO-IOC) and the World Meteorological Organization (WMO) **[1].** This paper discusses practical thoughts and ways toward early realization of this potential, with special focus on business model, while a variety of challenges is identified from technical, legal, regulatory and commercial perspectives among others.

1. INTRODUCTION

Thoughts and desires by scientists and governments to use submarine telecommunications cables for monitoring earthquakes and tsunamis have been around at least for the last decade. While some countries have submarine cable networks dedicated for monitoring earthquakes, tsunamis as well as some scientific data, many countries and organizations have not been able to justify the large amount of money to be spent for such a purpose. That is one reason why discussion on the potential of using submarine telecommunications cables for ocean and climate monitoring and disaster warning has become more active as importance in monitoring ocean climate changes and disaster warning through early detection of earthquakes and tsunamis increases.

While USA, Canada, some European countries and Taiwan have submarine cable-based observation networks, Japan has a longer history and experience of using submarine cable-based observation systems, and these could contribute positively in discussing the potential for dual purpose submarine networks which work for both telecommunications as well as observation.

2. HISTORY OF SUBMARINE CABLE-BASED OBSERVATION NETWORKS IN JAPAN

The oldest submarine cable-based observation network in Japan and probably in the world is the one built in 1979 for Japan Meteorological Agency, installed off Omaezaki, a peninsula in Shizuoka prefecture. The system uses coaxial submarine cable and it is still functioning today after 33 years of use. Since the first system was installed, Japan has had more observation systems around Japan. One of the reasons why Japan has been investing money in this kind of system is that the country is prone to earthquakes, and more of the larger earthquakes have their epicenters submarine rather than terrestrial.

Those systems are mostly owned by the Japanese government agencies and dedicated to observation and monitoring of earthquakes and tsunamis, and none of the systems is used for telecommunications purposes. This may be an important aspect to consider when we discuss the potential for dual purpose submarine networks which work for both telecommunications and observation.

Figure 1 shows locations of the major existing submarine cable-based observation networks around Japan. Apart from the systems shown on the map, there are several additional systems being constructed.

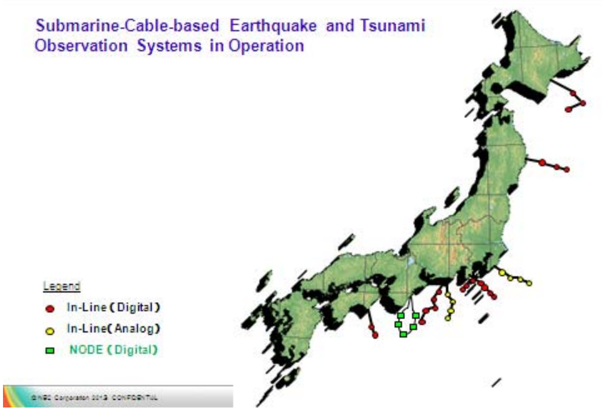

Figure 1 Major Submarine Cable-based Observation Networks around Japan (NEC estimate)

3. DIFFERENT TYPES OF SUBMARINE OBSERVATION NETWORK TECHNOLOGIES

Currently functioning submarine cable-based observation systems can be categorized into two major types; In-line systems and Node-based systems. Each type has its advantages and disadvantages, and owners of submarine observation networks have effectively been making choice on which type to be used. For the case of Japan, more than nine separate submarine cable-based observation networks have been placed on the coasts.

3.1. In-Line System

In-line systems have relatively simple network architecture, with seismometers and tsunami sensors (water pressure gauge or depth sensor) placed on the submarine fiber optic cable at a determined interval. Collected data at the ocean bottom are transmitted to a land station where terminal equipment is housed, and from there the data are further transmitted to users via terrestrial networks.

The Figure 2 shows a typical configuration of an In-line system. In-line systems utilize a sensor housing which is basically same in material as used for submarine repeater units, while size of the housing could vary. Sensor units used for In-line systems have typically had separate housing units for seismometers and tsunami sensors. However, a more recent In-line system uses one single housing for both seismometers as well as tsunami sensors, thus saving some cost and observation density.

Due to the use of robust sensor housing similar to those used for submarine repeater units for telecommunications cable systems with required 25 years of system life, as well as submarine fiber optic cables built to the same rigorous standards, In-line systems have longer expected life without wet plant maintenance over many years.

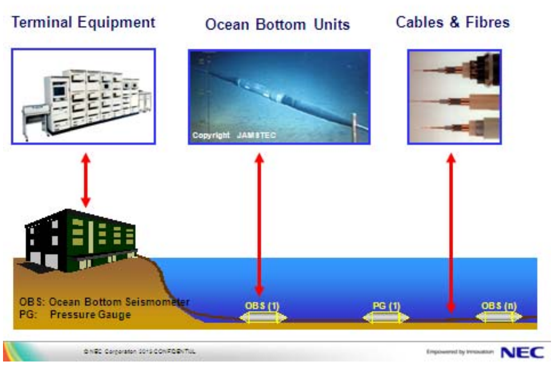

Figure 2 In-Line System (typical configuration)

3.2. Node System

A Node system usually consists of submarine optical fiber cable, a node equipped with wet mateable connectors, sensors for earthquakes and tsunamis and also for other purposes such as CTD (conductivity, temperature, depth), a branching unit and underwater extension cable to link a node and sensor units.

One of the representative Node systems is DONET (Dense Ocean-floor Network system for Earthquakes and Tsunamis) planned and implemented by Japan Agency for Marine-Earth Science and Technology (JAMSTEC) [2]. As its outstanding characteristics, DONET has flexible maintainability and future expandability thanks to the use of wet mateable connectors on the Node, by replacing sensors and/or adding more sensors for a variety of observation needs.

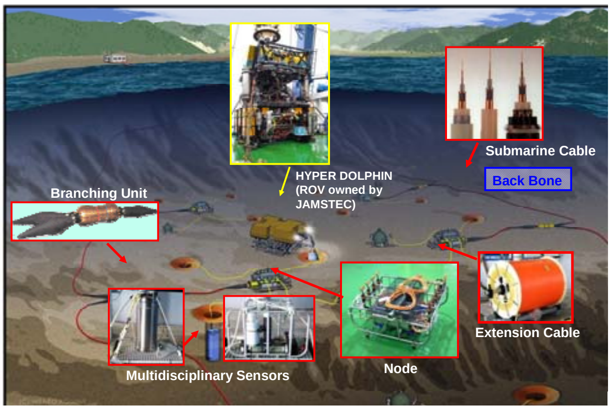

Figure 3 Sample Node System Configuration (Courtesy of JAMSTEC)

4. POTENTIAL FOR DUAL PURPOSE NETWORKS

While there are variety of aspects necessary to be considered toward realization of dual purpose networks, focus is given to technical, reliability and business model aspects here.

4.1 Technical Aspects

Technically, dual purpose submarine networks are available to be designed and implemented. Technologies required for the purpose has been developed through submarine cable-based observation networks for earthquakes and tsunamis, though integration of new types of sensors may require additional research. Repeaters with integrated sensors can also be developed using existing technologies.

4.2 Reliability Aspects

Long-term reliability of repeaters with integrated sensors, if they are built, has yet to be proven over the years. While submarine telecommunications repeaters are designed with 25 years of life, when sensors are integrated into repeaters, the original reliability would be affected. Under the conventional model of ownership, telecommunications submarine network owners will demand that no failure of sensor functionality would affect normal operation of telecommunications functionality of the network. This will be a crucial requirement that submarine telecommunications network owners will make when dual purpose systems are discussed. In response to this requirement, using separate sensor units from telecommunications repeaters may need to be considered. Also, an in-line system or a node system that branches out by use of a branching unit from the telecommunications submarine line may provide a solution for the reliability concern.

4.3 Business Model Aspects

What will be the business models that would motivate telecommunications network owners to allow integration of observation functionality into their communications networks? Here are several possibilities.

4.3.1 Owner Business Model

Telecommunications submarine network owners themselves become providers of observed data and make business. In this model a team enabling the observed data provision business would need to be established within the owner organization. In order for this model to be effectively used, advance arrangement with potential users of observed data and their commitment for purchase of the observed data will be necessary.

4.3.2 Consortium Model

Telecommunications submarine network owners and a group of observed data users (public research institutions, universities, government agencies, weather-related business, private researchers, think tanks, etc.) together build submarine cable networks for telecommunications as well as observation purposes. Construction cost will be shared at agreed rates.

4.3.2 Future Use Model

When telecommunications submarine network owners plan building a new submarine network, they integrate branching units at certain locations of the submarine cable. These branching units will provide connection for observation systems in the future either for an in-line system or a node system. This model can be effective when future users of observed data are identified at the time of start of a telecommunications submarine cable system construction, but funding is not ready yet. The initial cost of adding branching units and possibly additional fibers for future observation systems would need to be funded by the future users of observed data, or by the telecommunications cable owners with agreed terms and conditions.

5. CONCLUSION

A major challenge for dual purpose submarine cable systems to come to reality is that telecommunications and observation are separate and often conflicting interests. Those separate and conflicting interests would generate technical reliability concerns, project funding difficulties and ownership issues among others. Different business models and flexible network configuration (i.e., use of branching units, and/or use of separate sensor units from repeaters) may provide solutions for such conflicting interests, and therefore continued discussions among interested parties will transform the idea of dual purpose submarine cable systems into a reality.

6. REFERENCES

[1] ITU/UNESCO-IOC/WMO Joint Task Force website:
http://www.itu.int/en/ITU-T/climatechange/task-force-sc/Pages/default.aspx

[2] DONET – JAMSTEC website:
http://www.jamstec.go.jp/donet/e/index.html

