

## Analysis on Applications of Network Technology in Subaqueous Sensor System

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**Abstract:** For the quick development of wireless sensor network and more attention for marine cause from every country, study of the application of network technology in subaqueous sensor system has been the hot topic. The subaqueous sensors network is mainly made up of a great number of sensor nodes and few workstations. These nodes can obtain important information such as the salinity, water temperature and flow rate. In order to meet the requirements of marine exploration and detection, the equipment system has become more and more huge, leading the reliability reduced in some way. And this problem can be solved with the help of the new network technology like optical devices, communications protocol. In this paper, we take the significance, characteristics and problems of subaqueous sensor networks as the outset, then discuss how to ensure the reliability and usability and the application of optical devices in optical network. *Copyright © 2013 IFSA*

**Keywords:** Network technology, Sensor, Reliability, Communication.

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### 1. Introduction

Marine is very important for the national economy and defense construction. However to explore and exploit the ocean, the related equipments are quite necessary. Especially when the national safety, resources, food, sciences and disaster warning have been rising nowadays, the marine equipments have more complicated subaqueous sensor networks. At the same time, the bad environment in ocean, there usually are accidents just like supply interruption, cable breakage, corrosion, channel fault, noise jamming, anchor damage and so on. In order to meet users' requirements, the sensor system became more and more complicated, the parts also increased, leading the failure rate gone up and the using time

less. Therefore, how to keep the reliability and usability of the complicated huge network is now the problem in demand.

### 2. Development of Subaqueous Sensor Network

#### 2.1. Significance of Subaqueous Sensor Network

As a country with a large number of oceans, increasing of marine economy of China has become more important with the development of the economic construction. Now the research and improvement of the subaqueous sensor networks are

obtained lots of attention and investment from the related institutes and academic world.

Subaqueous sensor networks with low energy consumption, the characteristics of the short distance communication, and through the establishment of network node. By means of underwater sensor networks node can real-time data acquisition, monitoring, and then after processing, such as data fusion will monitor information transmitted to the surface by underwater transmission network nodes base station. The above information for Marine engineering, Marine, offshore production, resource conservation and environmental management provide the basis data such as disaster monitoring. At the same time, the development of underwater sensor network technology will also involve changes in the military field.

## **2.2. Applications of Subaqueous Sensor Network**

In recent years, the subaqueous sensor networks have been applied widely, the applications are mainly in the following field:

- Seafloor resource exploration, mainly used for the determination of submarine cable route, ocean oil field exploration, auxiliary mining, etc.;
- Data acquisition and obtain information such as chemical, physical, meteorological, acoustics;
- Environmental monitoring, implementation monitoring for water pollutants such as pesticides, analyzed the influence of human factors for the ecological environment, for fish and other creatures of tracking, etc.;
- Please alert again, by measuring the distance of seismic activity, can provide a tsunami warning. Strategy can be used in target detection, monitoring system, surveillance system, etc.

## **2.3. Characteristics of Subaqueous Sensor Networks**

### **2.3.1. Scale of the Network is Large**

Large amount including convenience of meaning first refers to the very large sea area, secondly to decorate a large number of sensor nodes in the test area. Because underwater sensor network information obtained under the different space perspective has a great deal of signal-to-noise ratio, but because of the existence of a large number of redundant nodes and to enhance the fault-tolerant ability, at the same time with the aid of information distributed processing method can effectively improve the monitoring accuracy. By setting a large number of sensor nodes in monitoring area can reduce the blind area of lake comprehensive hollow chances there.

### **2.3.2. Reliability**

Because underwater sensors are easy to be polluted or corrosive environment, combined with the node huge number, so can't for each node to effectively maintain, therefore full of in the design to ensure the robustness and reliability of the sensor nodes.

### **2.3.3. Self-organization**

As there is no infrastructure underwater sensor nodes are usually located in the position, each node cannot predict their own position, and at the same time is difficult to determine the location of the relationship between different nodes, and therefore require sensor nodes with a strong self-organization ability, thus through automatic management, configuration, monitoring data to be sent. If you use one of the nodes due to environmental factors or battery failure, then there will be another node is automatically added to the network.

### **2.3.4. Dynamics**

As discussed above, the Marine environment changes lead to aquatic communication link is not stable, combined with environmental factors, and its battery is low and so on will all cause node failure, because the sensor, the observer and the object of perception have mobility, this requires a system of underwater sensor networks can move refactoring to adapt to the change situation.

## **3. Improving Strategy of Reliability and Usability of Subaqueous Sensors**

Data transmission requirements of users for underwater sensor system can be outlined as follows: continuous, accurate clock, and high rate data stream. By using advanced network communication protocol and good fault tolerance core architecture and WDM technology and precise clock can achieve the above purpose.

### **3.1. Data Transmission**

For continuous data stream we can take the following measures: the advanced net communication protocol and the double redundancy design.

#### **3.1.1. Advanced Net Communication Principle**

RS - 232 in underwater sensor system, the Internet and the Ethernet protocol interface and protocol is

widely used, with the aid of the Internet engineering task force file RFC - 3550. The RTP, defined by the real-time transport protocol (RTP) collected data can be transmitted to the Ethernet. This protocol in the Internet is widely used in audio and video data transmission, especially for continuous transmission of data. This protocol engineer called RTP/UTP/IP/Ethernet, including UDP since the address for the user packet protocol, RTP/UTP data at the beginning of 20 bytes more than IP packets and ensures the RTP, good compatibility with the network and computer.

### 3.1.2. Double Redundancy Design

Between Ethernet and sensors by using the high quality of Ethernet switch can effectively improve the reliability and fault tolerance performance. At the same time to strengthen data transmission reliability, also double redundancy design is adopted in the system, such as for important Ethernet, power supply, cooling fans, switches, temperature sensors, are equipped with backup, an underwater sensor network as shown in the Fig. 1, some important parts are the dual redundancy design.

Debugging good sensor network can theoretically in the biggest potter than 90 % of the cases for data transmission, but in the actual operation to be on the safe side the baud rate are controlled at maximum baud rate below 60 %. Evaluation index of the total processing power of a computer for a specific period of time to complete the total workload, the index and the computer's operating system, network interface, system software and network switches are closely related. Underwater sensor system adopted by the transport protocol and packet size mainly depends on the computer processing power. But in sensor network design should strive to avoid packet is too large or too small, such as larger than 1500 bytes or less than 100 bytes, to prevent big packet lead to compatibility problems or buffer overload and small packets resulting system dealing with interrupt rate is too high. Practice shows that to control the packet size of 500-1500 - byte can effectively guarantee the data transmission and compatibility, give full play to the computer processing power.

Underwater sensor system, moreover, must carry on the strict before put into normal use, repeated testing, to prevent data loss and other problems.

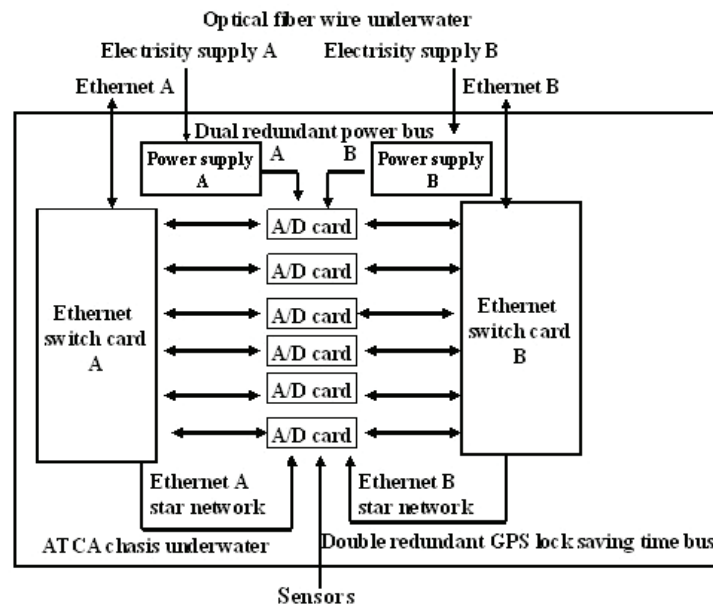


Fig. 1. Structure of the sensor system underwater.

### 3.2. Clock

The clock is the key elements in underwater sensor system. Scientific observation, for example to the sampling data and sampling time strictly corresponding, navy requirements by precise clock for target location and tracking, seismic to image with the aid of precise synchronization beam shape of the seabed, etc.

Now we can provide synchronization method has

two kinds: the first is by means of directional regularly send clock Ethernet packets to each node, receives the packet phase-locked loop integrated sensor node has data packets at moment is different, and got a stable clock frequency, average this one for synchronous clock method has been widely applied in small local area network (LAN) or audio network; the second is will SuoSuo deposit online a node's clock as Ethernet, but this method does not apply to multiple nodes connection, just

easy to realize the clock synchronization in the point-to-point connections.

That is commonly used in current Internet time protocol (NTP) synchronization between different sensor nodes can be accuracy control in 1-10 ms, but the accuracy is still cannot meet the needs of underwater sensors. And GPS clock wavelength division multiplexing (WDM) technology can provide a more precise clock synchronization and information, but this technology require specialized hardware, and applies only to optical fiber network. Besides the IEEE - 1588 precision time protocol (PTP) over the new standard for moderate, with the aid of a main inhibits PTP clock server equipped with a GPS receiver, can be realized to thousands of remote sensor node synchronization at the same time, its accuracy is as high as 30 ns. Inhibits PTP servers through exchange information on the delay time can be with each node on the network latency. But the technology is still in the R&D stage, believe that this technology into use can greatly improve and enhance the accuracy and reliability of the underwater sensor.

### 3.3. Application of Advanced Telecom Computing Architecture (ATCA)

After ensure the synchronous underwater sensor networks need to consider the reliability of hoisting system. Murphy's law shows that the various parts of a system failure may be produced, in order to guarantee the reliability of the system need to be the key for this double backup redundancy design subsystem, such as clock, backbone, and power supply system, etc.

Advanced communications, computer architecture, which is the core of the network

components with high reliability, strong interoperability, reliability and manageability of strong advantages, therefore very suitable for complicated underwater systems. This component can be inside the chassis power supply, circuit board, fan and temperature sensor for intelligent management and adjustment, at the same time management subsystem with double bus, so you can guarantee in a bus failure under the condition of stable running. Dual redundant Ethernet step structure for each of the ATCA chassis 14 CARDS are supported, including multiple ATCA chassis can be connected into a reliable network, thus excellent noise shielding, thermal management and monitoring features.

## 4. Applications of Novel Optical Devices in Optical Networks

Wavelength division multiplexing (WDM) technology is mainly to improve optical fiber utilization ratio and, through multiple wavelength multiplexing transmission in a single fiber. As WDM technology in recent years has increased, the reliability of the technology, cost and related parameters have greatly ascend, implements dozens of sensor is the purpose of sharing a single fiber. This new type of optical device is mainly composed of good fault tolerance and high reliability of optical device of multiple sensors in series in underwater sensor system, and the distribution for each sensor is only a wavelength to achieve communication with the device, the connection schematic diagram is shown as in Fig. 2.

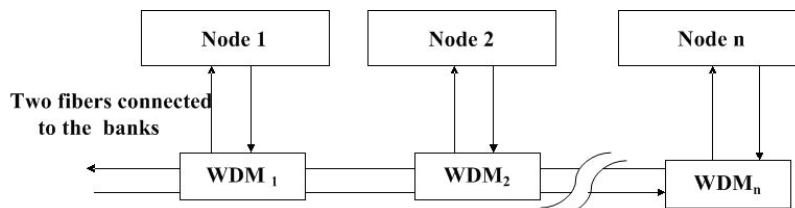


Fig. 2. Connection of sensors underwater.

The present popular standards for the use of this new type of optical device provides the technical support, such as applicable to different protocols and the rate of small hotplug transceiver, through the SFP connection with WDM and the other end connected to the Ethernet switches can separate the radio, film and television, which is convenient for fiber optic equipment configuration in the field of baud rate and wavelength. In addition, through technical research and development, manufacturers of SFP has carried on the further expansion of related function, such as increasing the number of the multiplexer and two-

way connectors, further simplified the connection of devices and network structure.

And optical amplifier and the forward error correction (FEC) are to promote the application of WDM network. For instance has an important role in the water industry of erbium-doped fiber amplifier with low coupling loss, high gain, low noise, wide frequency band and polarization insensitive, 15-25 db optical magnification can be effectively increased, extend the communication distance of sensor networks co., LTD.

## 5. Development in Future

The development of the subaqueous sensor network technology can be summarized into the following points through analysis of underwater optical fiber communication technology in recent years.

### 5.1. Light, Cheap and Low-energy

Because of the large optical communication on the platform of the main is a large submarines, aircraft, satellites, and therefore determines its high energy consumption, large power, high prices, and the characteristics of the large size. The underwater sensor has the advantage of small underwater platform, therefore both frogloks, AUV sensor requirements of wireless optical communication equipment, low energy consumption, light weight, low price, which is convenient for underwater sensor in widespread use in the sea, exert its advantages.

### 5.2. Faster Transmission

Compared with underwater acoustic communications, underwater wireless communication has the advantages of high transmission rate. And the communication rate is by the initial thousands of potter gradually increase to 1 GBPS per second, and from the initial development to the present data transmission of audio transmission and real-time video transmission, etc., believe that with the continuous development of communication technology, the technology transfer rate will be higher.

### 5.3. Diversified Ways of Communication Underwater

Underwater optical communication technology is started at the beginning of the use of direct line-of-sight communications, and this technology has been unable to fully meet the needs of complex environment, for the transmission of underwater wireless communication link gradually abundant. Underwater echo communication technology due to the communication port don't need light source, therefore greatly reduce the communication side of the weight, volume and power consumption, which

reduces the communication node in the manufacturing costs, to popularize and apply this technology has played a good role in promoting.

### 5.4. Point to Point Link Communications Develops to Networks

More than the development of technology further prompt communication network applications, have greatly enriched the node scope of work space, prolong the working time. Current research network technology application in underwater sensor as hotspots are rapid development, especially as new optical devices in optical networks, the application of the development of underwater sensor networks shows the great application prospect.

## 6. Conclusion

With the help of advanced devices, technology and standards, the establishment of marine equipments system can be promoted, and for requirements of national safety, resources, foods, environment detection, science exploration and the disaster defense are increased, the marine equipments combining with the network technology in future will need efforts in higher rate and reliability.

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