# The Design Prototype of Shore-side Data Management and Service System of Ocean Observing System in South China Sea

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***Abstract*—In order to enrich economic value of ocean and to provide a convenient and efficient research platform for researchers, a deep-sea submarine observation network in South China Sea is being built. This article describes the prototype of Shore-side Data Management System of the deep-sea submarine observation network in South China Sea, and introduces the overall situation and the system architecture, especially data acquisition, data transmission, dynamic parser, service architecture and virtual cooperation. The validation of concurrency capacity is taken into consideration to improve the system performance in the next release. The deep-sea submarine observation network is mainly expected to become a science-driven system, to meet the requirements of research, public and education users.**

***Keywords—Shore-side Data Management and Service System; data acquisition; data transmission; concurrency validation***

## I. INTRODUCTION

In order to achieve further breakthrough in the technologies of nodes selection, network deployment and maintenance, system control and in-situ multi-parameter detection in the submarine observation network; to improve the development of key equipment and systems such as the photoelectric composite cable with wet plug interface device, deep-sea connection equipment system, undersea environment long-term real-time monitoring system, shore-based diagnostic control management and maintenance system; and to complete the formation of the correlative technical standards, a deep-sea submarine observation network test system is planned to be built in the South China Sea, as shown in fig. 1.

Near the coast of South China Sea, a shore-based operation management system is built in the shore-side station. It mainly realizes monitoring and managing status of the underwater sensor devices by the shore-based server and underwater junction boxes. It is the most direct information management center of the underwater junction boxes and various equipment of the seafloor observatory network.

Real-time operating status of each deep-sea submarine observation equipment, is obtained by the detection of the electrical energy supply device, transferred to the junction boxes and then sent to shore-side control computer via the switch. This whole process is under the control of shore-based communication and control computer. Shore-based management server takes charge of data pre-processing and real-time data displaying with interactive interface. The operators of the management system could accordingly monitor and control the submarine observation equipment. At the same time, to prepare for future needs, communication control server sends the status information to the database server and store it in that server.

In Shenzhen, Guangdong province, a data management and service system [1] is built. It contains the software of system control as well as data process of the deep-sea submarine observation network, and realizes efficient acquisition, classification, achievement, and storage of multi-type, multi-disciplinary and multi-source data. To consider different users' requirements, related aspects are studied, including data visualization, distributed and massive data integration and sharing, data security and other technology.

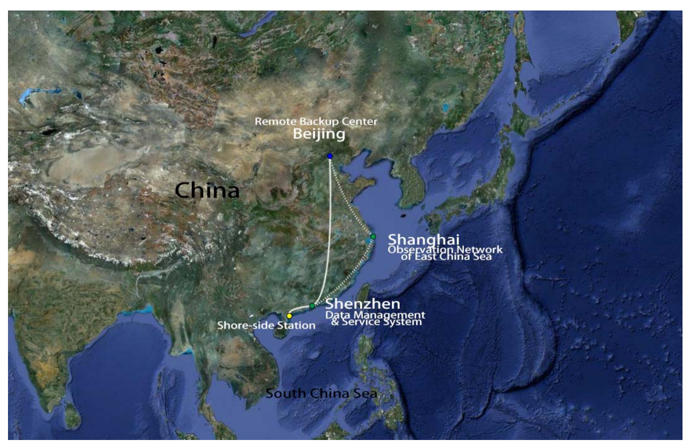


Fig. 1. Geographic location

In Beijing, a remote backup center is built. Nowadays, with the development of large-scale distributed database technology, it is effective to employ multi-site backup to reduce scale of design and loading pressure of each database center, and to greatly improve the bearing capacity to maintain the normal

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operation of the data center in some unexpected situations. Besides, large-scale real-time online data support network that provides data support for online services with the establishment of two or more data centers, could bring about highly prominent advantages such as load balance of query operation and reduced delay of network access.

In Shanghai, there is also an ocean observation network, called the deep-sea submarine observation network of East China Sea. The dashed line in fig. 1 represents the situation that if two fiber-optic lines could be established (Shenzhen to Shanghai and Beijing to Shanghai) a data integration and transmission circle network [2] will be formed. Once fiber optic hardware damages, it will take a long time to restore the fiber and greatly affect the data consistency between the two data centers. And after the maintenance, both pressure of data access and usage of communication bandwidth will be extremely high during the data synchronization, which will lead to certain risks for the online applications. Storing data in multi-area cannot only avoid some unexpected risks but also insure the network transmission. If the fiber-optic lines (dashed line in fig. 1) can be established, performance improvement, data integration and risk control will be benefited.

System software target:

- Support two primary junction boxes, extensible (as shown in fig. 3);
- Support eight primary junction boxes, extensible;
- Support 60 sensor platforms, extensible;
- Support PC, tablet and smart phone access, and support mainstream browser version;
- Continuous work for 7 * 24 hours;
- 5000 users online at the same time, 10000 users in next release;
- 400 concurrent operations, 1000 in next release.

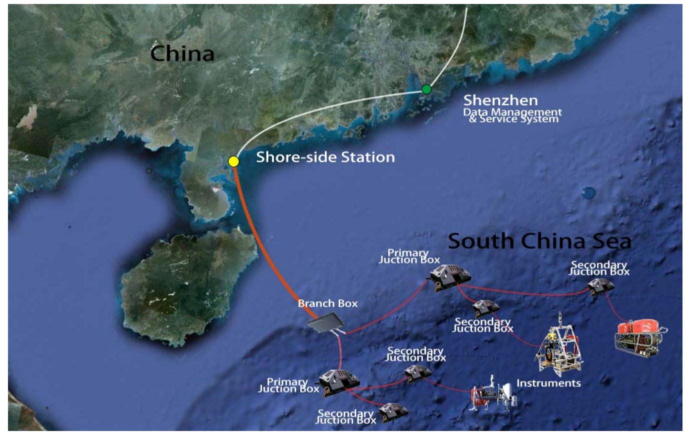

Fig. 3. Underwater environment diagram

## II. SYSTEM ARCHITECTURE

System architecture is shown in fig. 2.

There are 3 parts, including data acquisition, data parse and transmission, and web service.

### *A. Data Acquisition*

As shown in fig. 2, instrument layer contains ADCP, CTD, ADV, in-situ micro particle velocity meter, chemical environmental monitoring device, seismograph, magnetometer, and cameras. The primary junction boxes and secondary junction boxes provide power energy and control signal for instruments and acquire real-time data via RS-232, RS-485 and RJ-45.

The backbone network takes charge of transmission of large amounts of data via fiber-optic communication from the junction boxes to the shore-side station. TCP / IP protocol suite and custom communication protocol (including communication frame's format, content and so on) are used as standardize communication protocols. Each data source uses a separate IP address. Operation and management system needs to communicate with the database server and to send the

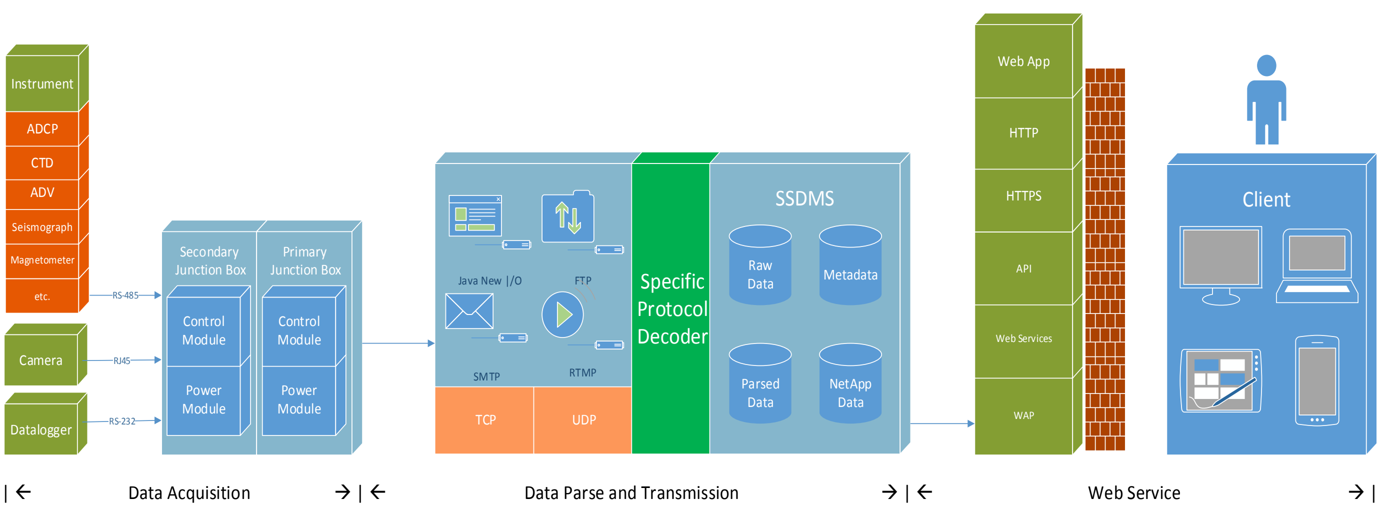

Fig. 2. System architecture

package of status information to the database server for storage.

At the same time, the input and output signals of each module are also detected, and the system uploads the monitoring status to the server via RS-232, including the status of the automatic conversion system, the working status of UPSs, the status of controllable switches, the output status of the power supply cabinets as well as the status of junction boxes.

### *B. Data Transmission*

The data transmission and communication framework is shown in fig. 4.

Deep-sea submarine observation network builds a high-performance communication framework that is based on MINA [3] framework includes connection management layer as well as dynamic parsing layer and is mainly to meet the conditions of various different communication transports and sensing equipment, and to satisfy the demand of high concurrency, high real-time and high scalability.

Connection management layer that contains session management and thread scheduling is implemented on API of MINA filter.

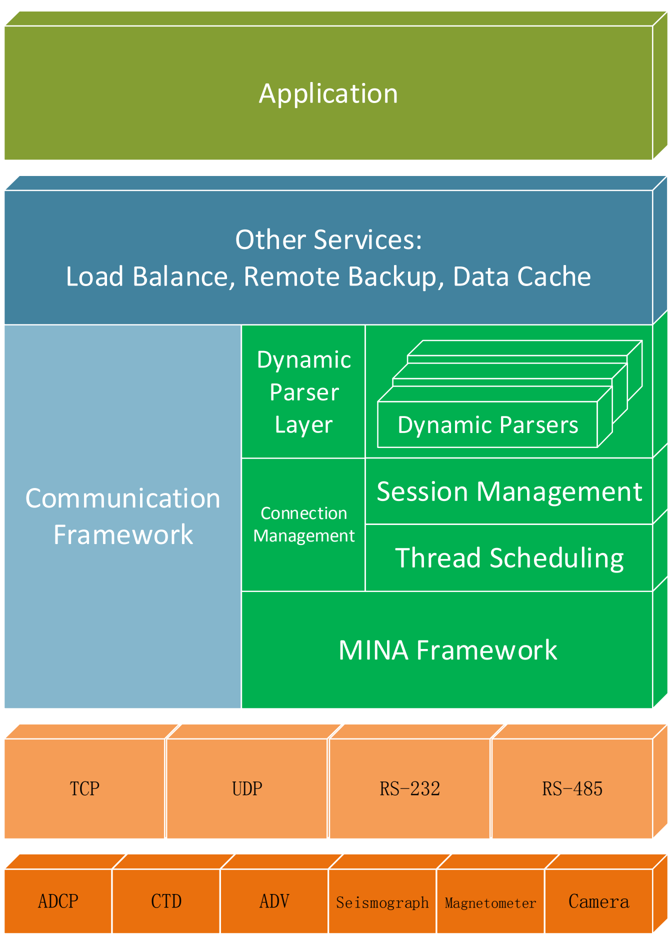


Fig. 4. Data transmission and communication

The session management takes charge of communicating with different types of devices, receiving the data sent from observation devices and sending control information back to the devices. It's the foundation of compatible communication architecture of the entire communication framework. Also, it is implemented by using MINA-based communication model, by fully meeting the requirements of access of massive devices and solving the compatible communication problem between equipment and data center.

Thread scheduling management is used to optimize the scheduling strategy of working threads, to increase the throughput capacity of the processing units and improve the overall performance of the system to meet the requirements of high concurrent and high real-time.

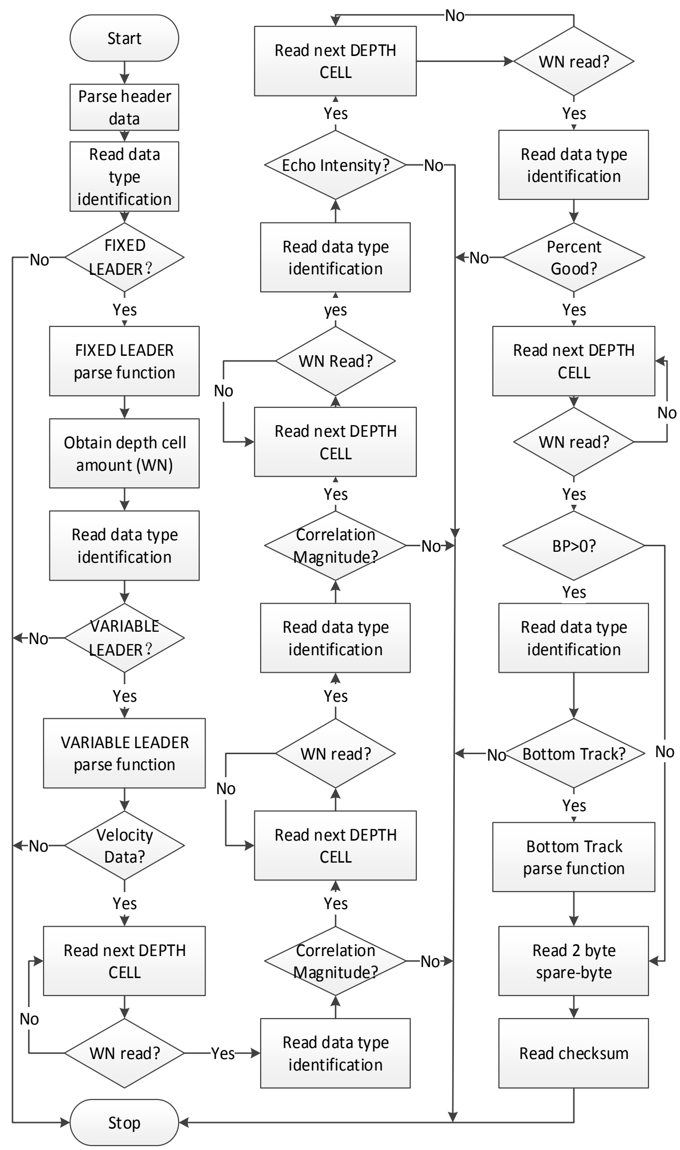


Fig. 5. ADCP parsing process

In dynamic parsing layer, parsed XML format file is changed into class format file and then is loaded into the JVM by the dynamic loading services so that parsers can be generated dynamically based on communication protocol configured online. It is convenient to support new kind of observation equipment, which basically realizes plug-and-play and dynamic configuration.

ADCP [4] parsing process is an example of details of parsing process, as shown in fig. 5.

Some other services are integrated into the upper end of the pre-communication layer of the data management system, such as load balance, remote backup, and data cache. Communication services that are high concurrent, high real-time and highly scalable [5] are combined together at the lower end so that they can provide application services for the data management and application system in the upper level.

### C. *Web Service*

Web service architecture is shown in fig. 6.

Several categories of services, including data products,

code runner, visualization and virtual co-operation services, are provided for the scientific, education and public users.

services can be refined as the real-time data display, data query, data download, data plot, video products, data calculation, data analysis, and some other services provided by third-party plug-ins or service providers such as wiki, blog, video conferencing, GIS visualization and SMS pushing services, to fully meet the research needs of scientific users and cognitive needs of public and education users.

User authentication and device management services are provided for background administrator users. User authentication service, which is established by user information management, organization management, and privilege management, is supported by basic authentication technology. Equipment management services based on sensor configuration, status management services forms running control service, which achieves unified management of equipment under the combination of organization management

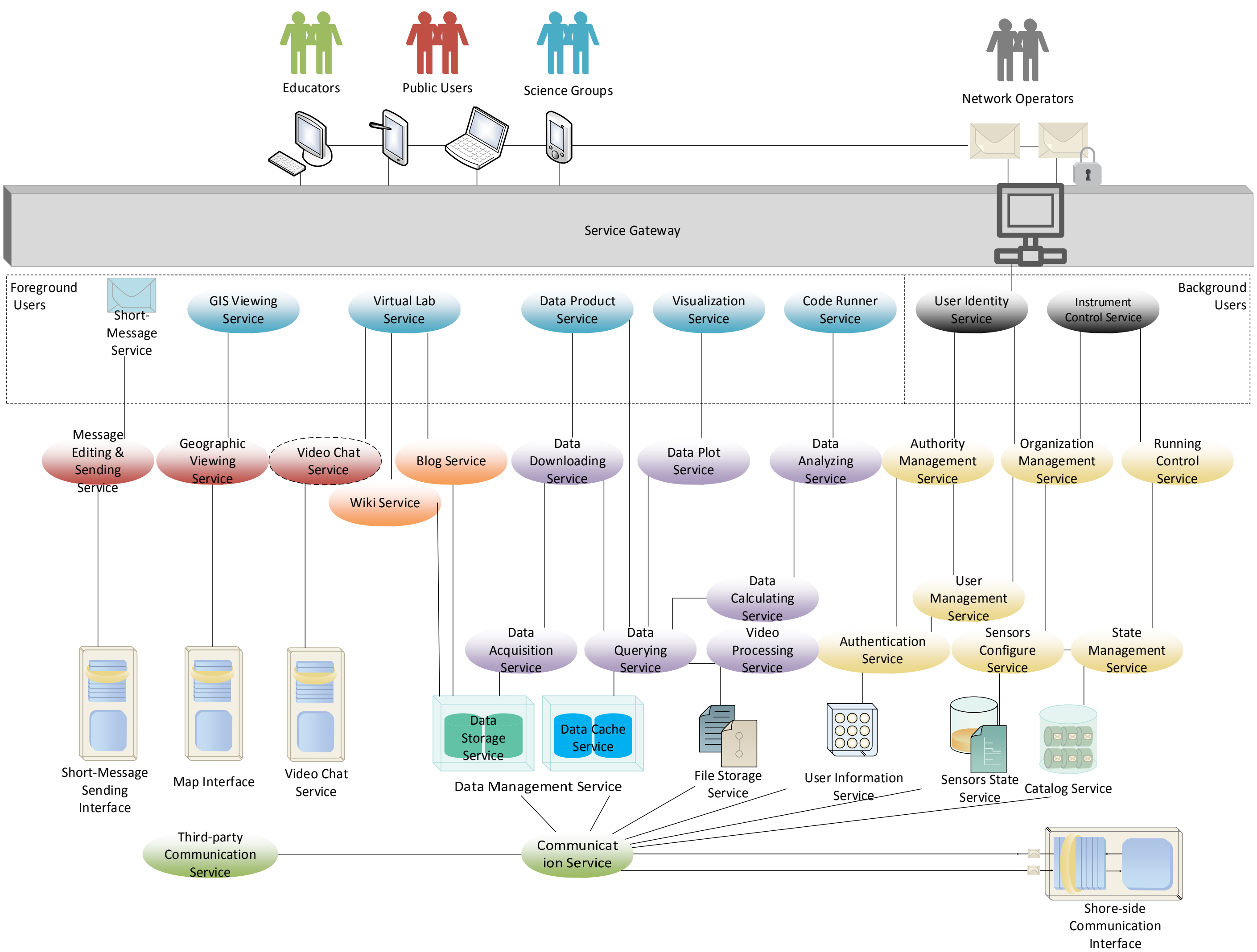


Fig. 6. Web service architecture

service.

After passing validation of user authentication service via HTTP and/or HTTPS protocol, all users can access the user-oriented services by using personal PCs, smart phones and tablet devices.

### D. *Virtual Cooperation*

Virtual lab environment is shown in fig. 6.

Collaborative experiment, namely that researchers can cooperate in data analysis and modeling, practicing ideas, sharing documents and information and modifying the observation program to form a virtual lab environment [6], can provide a convenient and efficient research platform for researchers and can promote scientific discovery and innovation. It contains the following characteristics:

Research teams are formed in research topics. Document and code scripts are shared in private or in groups. Each researcher can not only develop their own research programs and configure parameters but also share their own plan and documents to other members of the research team. Documents can be easily shared between group and group, between individuals, or between groups and individuals;

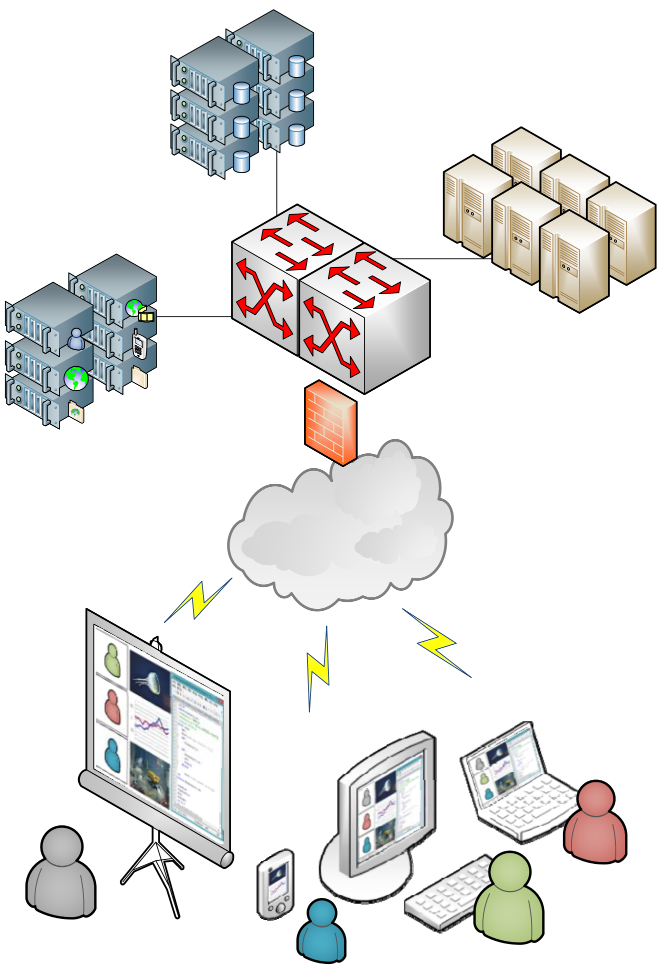

Fig. 7. Virtual lab environment

Instant messaging services are provided to set up a research and discussion environment. Researchers can communicate with their groups via text messaging, voice messaging and video conferencing. These text, voice, and video clips will be saved online as chat history;

SVN feature is integrated to help document sharing, allow

scientists with the right privilege to edit documents, model parameters and code script online at the same time;

Video streaming, plot of real-time data and result of data analysis are displayed synchronously on researchers' clients who are in the same research topic group, which facilitates correcting models for scientific research.

### E. *Concurrency Validation*

HP LoadRunner [7] was chosen as the test tool to examine system behavior and performance.

Three metrics were chosen as the main evaluation criteria, including Running Vusers, Total Transaction per Second, and Average Transaction Response Time, as shown in fig. 8.

And the hardware configuration is a non-cluster server, which is Intel Core i5-2400 3.1GHz CPU, 2G DDR2 RAM and SATA2 hard disk.

The number of Max Vusers is set to 200, which means the number of users who click at the same moment is 200, and that probably equals to 3000 users use the system at the same time.

The view of Running-Vusers drawn in green color showed that user loader loaded 5 users every 15s, as set before. After reaching 200 and continuing 15 minutes, user loader gradually released Vusers.

The point drawn in purple color that represents Total Transaction per Second showed that the total number of passing transactions per second in the running of the scene is about 5.

And the Average Transaction Response Time was increasing correctly with the growth of the system load. If the usage percent of RAM is increasing to 80%~90%, it costs more

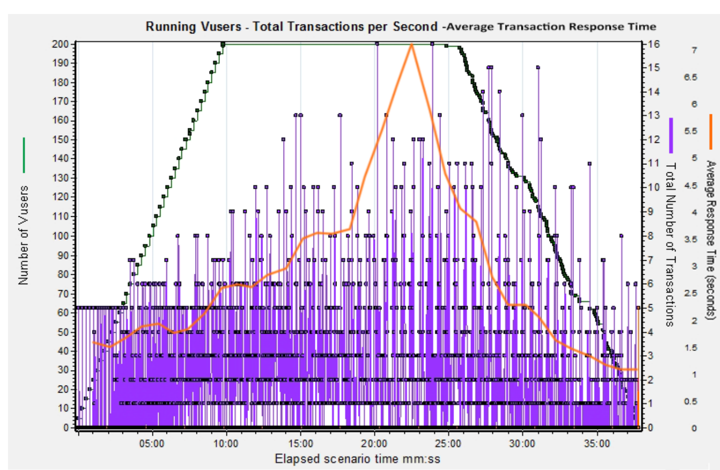


Fig. 8. System performance in concurrency

time to exchange data and the Average Transaction Response Time is affected to increase to 7s sharply. For the developing environment is just a non-clustered server, the level of time response is acceptable. The hardware will expand to cluster server, and the scale will increase to 10000 users and 1000 concurrent operation (value of Max Vusers) in next release.

## III. SUMMARY

Deep-sea submarine observation network in South China Sea is being built to promote scientific discovery and innovation. Shore-side station, data management and service system and remote back-up center are located in three cities and those three are planned to link up with the deep-sea submarine observation network in East China Sea to integrate observation data and improve the scale of research.

Parsers are generated dynamically into JVM and this generation realizes plug-and-play and dynamic configuration, avoids installing specific driver module for devices underwater and helps to get raw data directly.

Services, especially virtual cooperation, online code runner and visualization services, are designed to provide a convenient and efficient research platform for researchers. The deep-sea submarine observation network is mainly a science-driven system, which means large-scale computing and storage resources would be integrated into the network. Also, the deep-sea submarine observation network will meet cognitive needs of public and education users.

Current tests show that the system can deal with the concurrency problem at the scale of 3000 users online at the same time and 200 concurrent operations. The situation of 10000 users and 1000 concurrent operation will be tested in next release after the hardware is expanded.

## ACKNOWLEDGMENT

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