

Development of object-oriented data acquisition system for LHD fusion plasma experiment using O2 database

Emoto M., NIFS. Toki, Japan, emo@nifs.ac.jp

Kodaira J., NIFS. Toki, Japan, kodaira@nifs.ac.jp

Kojima M., NIFS. Toki, Japan, kojima@lhd.nifs.ac.jp

Komada S., NIFS. Toki, Japan, komada@lhd.nifs.ac.jp

Nakanishi H., NIFS. Toki, Japan, nakanishi@lhd.nifs.ac.jp

Ohsuna M., NIFS. Toki, Japan, ohsuna@lhd.nifs.ac.jp

Sugisaki H., CTS-SP. Nagoya, Japan

Sudo S., NIFS. Toki, Japan, sudo@nifs.ac.jp

Abstract

The data acquisition system using the object-oriented databases has been newly developed for the LHD fusion plasma experiment. It is designed entirely to be based on the object-oriented methods, and its application programs for the data acquisition and storage are all written in the object-oriented programming language Visual C++ on Windows NT. The data management programs consist of hierarchical class definitions that have the diagnostics, the CAMAC module, and the module channel class. The lowest channel **objects contain** the substance of the diagnostic data. As for the data object archiving, the object-oriented database management server product, named O2, is applied to each diagnostic acquisition computer locally. It enables to store and retrieve the whole data object directly into/from it. For compacting the data object size and improving the database transaction throughputs, the archived-channel class is also applied in which the raw data block is compressed by GNU-zip library engine named zlib. Archived-channel objects are held in the bag **objects that** are made for each discharge experiment and each diagnostics. As the data retrieving user terminal, the data **visualisation** products IDL or PV-WAVE are applied in which the O2 client function can be called through the Windows NT DLL.

1 INTRODUCTION

At the National Institute for Fusion Science, LHD (Large Helical Device) experiment has begun on 31st March 1998. LHD has many diagnostics devices to study various aspects of the plasma in it, and each of them produces about from 1.5 to 24 MB data per one plasma shot. And plasma is discharged each 3 minutes. Then the data acquisition system must acquire the data from those diagnostics devices via the optical fibre and store it to the database for immediately view by users in 3 minutes. Then job for development of the data acquisition system is huge, and it is necessary to divide job for some

programmers. For easy job division, the data acquisition system is designed entirely to be based on the object-oriented methods. The program is written in C++, and O2 database is adopted for its database. Both C++ and O2 are object-oriented. They make the data acquisition and storage function be described autonomously and make the source code more recyclable.

For finishing acquisition and storage in 3 minutes, the data acquisition system acquires the data, compresses it, and stores it. By compressing it, the system decreases the data size and the database transaction. Compression needs a little time, but the system runs in multi-thread, and acquisition, compression and storage are done concurrently, then total of time does not increased.

2 BASED ON THE OBJECT-ORIENTED METHODS

The system is designed to be based on the object-oriented methods in order to increase the efficiency for development.

2.1 Diagnostics Objects

For LHD plasma diagnostics, CAMAC is used. CAMAC has some modules, and one module has 6 channels. By the object-oriented methods, CAMAC diagnostics, modules and channels are described as objects in the program of data acquisition system. Diagnostics object manages whole CAMAC system, CAMAC module object manages the actual CAMAC module, and module channel object manages the actual CAMAC module channel. Like the actual CAMAC system is hierarchical, the definition of classes is hierarchical. A diagnostics object has some CAMAC module objects as same as a CAMAC has some modules, and a CAMAC module object has 6 module channel objects as same as an actual CAMAC module has 6 channels. For the data acquisition, the module channel

object acquires and stores the data of the actual channel that it correspond to.

2.2 Database Objects

In the database, there are archive shot and archive channel objects. The archive shot object has some parameters and some archive channel objects. The archive channel object has some parameters and the diagnostics data buffer. For data acquisition and storage, the system makes an archive shot object that has the present shot number and archive channel objects have same number of the actual CAMAC channels. The archive channel object receives data from module channel object, compresses it, and stores it to its own data buffer. After all data are stored in archive channel objects, the system stores them with the archive shot object. When users retrieve data, the system refers the archive shot object by the shot number that users want to view and transfers archive channel objects of that archive shot object to user client machines.

3 DATA COMPRESSION

In order to improve the database transaction throughputs, the system compresses diagnostics data before stores it. In fact, the archive channel object compresses and it makes other thread for compression. Then the system can acquire data consecutively, and data that has been acquired is compressed concurrently. In view of these facts, the data acquisition system can acquire and stores data to O2 database in about 40 seconds in case that CAMAC has 10 module (60 channel) and it produces 15-MB data. Additionally, data compression is effective to decrease the necessary RAID disk space and time for data backup.

4 DATA VISUALISATION

For viewing the acquired and stored data, the data visualisation system is necessary. For it, the data visualisation products IDL or PV-WAVE is applied in which the O2 client function can be called through the Windows DLL. Users can retrieve data by awarding shot number and channel number to this DLL and view it graphically by IDL or PV-WAVE. The data acquisition system can acquire and store data in several ten seconds, then users can retrieve the newest data of plasma with a little delay after it is discharged. The data in O2 database is compressed, then the DLL uncompresses it after gets it. Therefore, the size of data running on the network and the time to transfer the data is reduced. And by uncompressing on the client machine, the load of the server machine is reduced.

5 GENERAL

By using the object-oriented methods, the data acquisition system is developed very efficiently. It is

described by hierarchical classes, and they make the source code of the system self-intelligible and functionalized. And by using them, development can be done in the short term and by limited manpower.

An additional feature of the data acquisition system is that it stores data to database directly by using O2 database object. It uses the compression method, therefore the storage space in database occupied by diagnostics data is reduced and performance of the system and throughputs of network traffic are improved.

For data visualisation, IDL or PV-WAVE is applied, and it can always view data in the midst of the LHD experiments. For access to O2 server, the O2 client DLL is made, then users can retrieve data by only assignation shot number and channel number.

Current system can acquire and store diagnostics data in a matter of several ten seconds, such as about 40 seconds for diagnostics device has 10 CAMAC modules. It is enough performance for current LHD plasma experiments.