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Objectivity/DB system at CCJ for the PHENIX experiment

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Recently, Object-Oriented(OO) techniques for software development have attracted wide interest in the field of experimental particle/nuclear physics. Many experiments in LHC, SLAC, FNAL and RHIC are developing their software using the OO-techniques. The C++ programming language is the most popular OO-programming language and many experiments adopt this language at present.

In C++, it is not very easy to communicate outside of the process in the Object-Oriented manner. Communication between *Objects* on memory is realized using a *pointer* or a *reference*, while it is nonsense to write a *pointer* to a file. A user of C++ has to develop his or her own methods to input/output the *Objects* to/from the files on a disk or to/from inter-process communication methods as a *socket*, because C++ does not support such methods. In other words, C++ supports only the *Objects on memory*, but does not support the *Objects on disk* or *Objects on network*. The Object-Oriented Database (OODB) helps to input/output the *Objects* to/from the disks transparently. The *Objects* persistently exist on the OODB instead of existing transiently on the memory of each process. (For the network case, the Object Request Broker(ORB) helps.)

The Objectivity/DB[1)] system is one of the commercial Object-Oriented Database Management Systems. It has been studied through the CERN RD45 project[2)] and the ATLAS experiment, and has already been used in the BaBar experiment.

The PHENIX experiment also adopted C++ to develop their online/offline software, and decided to use the Objectivity/DB for their main database. The main DB includes detector calibration data, high voltage values for the detectors, the run information and so on, although there is no plan to include raw data or Data Summary Tapes (DST). The high-voltage data part of this main DB system was already used throughout the last run in 2000. The calibration-data part is partly under development and is used in the reconstruction process, which makes the DST from the raw data. Collaboration-wide license of Objectivity/DB permits the use of the system in any institute in the PHENIX collaboration.

Also in CCJ[3)], we are supporting the access of the PHENIX official database (PHENIX-DB) for regional users who would like to analyze the raw data. Various ways to support the database are discussed. A) To make a 'snap-shot' of the original PHENIX-DB on BNL using the tool built in the Objectivity/DB system. It supplies a dead copy of the PHENIX-DB on the disk at CCJ and the user can read it and obtain the same data as in BNL. B) Direct access to the original PHENIX-DB on BNL from CCJ via a Wide Area Network (WAN). Objectivity/DB supports two access methods via the network. One is via the Network File System (NFS), and the other is via the Advanced Multi Thread Server(AMS), which is the original technique of Objectivity/DB. In a WAN environment, AMS is a unique solution in fact. We have accessed via AMS and measured the overhead time caused by WAN between CCJ and BNL. It is in the order of 20 to 30 minutes for a typical PHENIX official reconstruction routine which requires only 20 to 30 seconds to read a local database. This overhead time is significant. Moreover, possible *locking* of the PHENIX-DB caused by this long-time and unstable access may bother the users in BNL. Users who were accessing the DB were already bothered in the last run by the *locking* of the PHENIX-DB caused by dead processes or living and forgotten processes in BNL.

Now method A) is adopted in CCJ. Each time a major update is made at BNL, a 'snap-shot' of the PHENIX-DB is created and copied to CCJ by hand using the built-in commands *oobackup*, *oorestore* and *ooinstallfd*. Many users of CCJ have already used the copied DB and analyzed raw data for their own interests as detector calibration.

The current size of the PHENIX-DB is approximately 600MB, and the copying process takes about 10 minutes. It is not heavy at present, but it is projected that the DB size will reach an order of 10GB. In such a case, it is difficult to copy the entire DB; thus incremental copying is preferable. There are two methods to realize the incremental copying. One is C), called *Replication*, supported by the Objectivity/DB system, which makes a copy (or copies) of the DB in real time. Connections between DBs are kept permanently and an update of one DB propagates to other DBs automatically. However, the problem of *locking* in the unstable WAN environment also exists. Another method, D), uses a special tool developed in the BaBar experiment at SLAC. The people in Babar use Objectivity/DB for the data storage and copy the data from Objectivity/DB to outside of SLAC incrementally using their special tool[4)]. We plan to contact them and study their tool to determine whether it is suitable for our usage or not.

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References

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