THE DESIGN AND OPERATION OF CWB GDMS

Mark Cheng
Central Weather Bureau
Taiwan, R.O.C.

ABSTRACT

Through the use of Client-Server based technique and automated binary conversion facility, CWB's Grid Data Management System (GDMS) provides a heterogeneous network transparent environment for the grid data access and management of daily operational NWP system on CRAY and its post processing system on various UNIX workstations as well as the data transfer between operation and research environments. The GDMS now handles CWB's current developing second generation global and limit area models' outputs and post processing approximately 1 GBytes a day. The preliminary result shows the performance and stability is quite acceptable.

1. BACKGROUND

It has been decade since CWB initiated it's computerization project in 1984. These ten years can be seperated into two phases from 1990. The main goal for the first phase is not only to build up the basic automatic meteorological operating environment and numerical weather prediction system but also to educate and train people with various related technique. However, the main goal for the second phase is to integrate all seperated meteorological data processing systems and extend a more advanced NWP technic to promote the quality of NWP model. In these two phases, from 1987 (initiate use of CYBER 205) to 1992 (initiate use of CRAY8I and CRAY2E), the concept of system operation has been widely amended from centralized processing to networking distributed processing. To efficiently support the operation of NWP system and it's post processing system in this network environment, CWB decided to develop a client-server based Grid Data Management System (GDMS) to provide heterogeneous network transparent access capability for the daily operation of NWP system.

2. CWB NETWORK ENVIRONMENT

Fig. 1 shows the network architecture inside CWB. The center of this network is the NWP system connected with FDDI ring. To CRAY, a 1.2 TB Automatic Cartridge System (ACS) is attached. At left side of the ring, the Automated Meteorological Data Processing System (AMDP) is responsible for the decoding and error checking of all the weather codes which come from GTS communication line. At the right side of the ring, the Graphic System (GRPH) is responsible for all the plotting work of NWP output grid data. Besides the operation of GLOBAL and REGIONAL model, there are still some other NWP related systems for archiving, evaluation and model climate calculation in operation at CRAY.

In addition to central FDDI ring, the other part of this network is constituted by pure Ethernet. The right side of this chart is the old NWP system including two CYBER 840 and one CYBER 205, the General Public Meteorological Information Server System (SERV) and R&D environment from the top to bottom respectively. The left side of this chart is the Weather Integration and Nowcasting System (WINS) which consists of two VAX 6510 and several UNIX graphic display workstations. The main purpose of this system is to provide forecasters an integrated working and displaying environment to help them process the weather forecast procedure in a timely fashion. Moreover, this system including a professional Meteorological Information Service System supports several other Meteorological forecast offices, not only to CWB. The lower part of this chart is various data sources processing system of CWB. The lower left system is the surface observation system including 25 meso scale automated station and around 400 rain gage precipitation network. The lower right system is the radar observation system which includes 2 conventional RADAR and 2 Doppler RADAR located in the north, middle, south and east part of Taiwan. There is also a new NEXRAD station currently under constructed at north tip of Taiwan which will be connected to this network.

3. OPERATION CONCEPT AND REQUIREMENT

In the network operation environment described in previous sections, the output grid data of NWP system does not only been provided to self-operation but also to WINS, GRPH, SERV and R&D systems. Especially in R&D environment, there are cross access requirements to each other's data base. The overall operation concept of GDMS is shown in Fig.2. Although CRAY is the main data server in this case, in fact, any node in this chart can be the server of other nodes. At the lower left side, the cache disk provides a path for automatic migration from CRAY local file system to ACS. By proper sizing and aging control, user files can be transferred transparently between cache disk and ACS. Client 1 in this chart means the users at FDDI ring while client 2 means the users at Ethernet.

To provide the data access for NWP operation and scientific research in such a heterogeneous network environment across different hardwares and softwares platforms with unified data access interface, the basic requirements for GDMS development can be concluded as following:

⋆ Simple and clear user interface for meteorological scientist to use

⋆ Client-Server based architecture with transparent heterogeneous network access support

⋆ Multiple storage software platform support

⋆ Accessing and logging control for security and debugging

⋆ Record level locking for concurrent access

⋆ Make use of CWB current Mass Storage System (MSS) environment

⋆ Exception handler for data integrity and gracefully exit

4. GDMS ARCHITECTURE

Fig 3. shows the architecture of GDMS. Because of layered design, it become very facile to implement and maintain this system. As shown in figure, UFS, EMP, GDB and NET are access software platform dependent modules to provide unified access mechanism above UNIX file system, Empress DBMS, GNU DBM and network access respectively. TRANSLIB is the module under NET to provide binary conversion across different hardware platforms. The module above these ones is the security/logging/exception handling layer. By the names of those modules, the functions can be obviously realized. One more layer up is the C language application interface. Because most of the meteorological scientists use FORTRAN language to develop code in CWB, we hereby provide a module to interface the FORTRAN and C language. Besides these interface calls for applications, this system also offers a set of command level utilities for interactively authorize the users to manage their own data base or use command languages to do some other individual works. Pairing to NET module (the GDMS client module), there is a server module named GDMS server which provides the network service requested by users on the other nodes. Because of using existent UNIX "rexec" mechanism, the complexity of network programming can be minimized in order to focus on the development of communication protocol.

5. GDMS FUNCTION

The function of GDMS consists of two parts, utility and data application interface. The utility part can be divided into three parts: administrative, query and operation. Administrative utility provides the create, drop and re-organize operations for data base and also provides access grant and revoke for security. Query utility provides the query of data base information which includes the existence, access privilege, record inventory, and record contains for one or some record. Operation utility provides the capability for user data exchange between data bases and/or files which include load(import), dump(export), copy(between DBs) and delete(for removing record). The data application interface can be divided into access, query, operation and miscellanies four parts.

Access interfaces provide the access initialization and exiting to data base which includes init, open, close and exit interfaces. Query interfaces, just like the part in utility, provide user interface to query for the existence, privilege, sizing and record inventory of data base. Operation interfaces provide the channel for data flow between data base and user program memory including get, put and delete operations. Miscellanies interfaces provide the logging, control, exception handling, C and FORTRAN language interface.

On the support of data types, GDMS can accept integer, long, float, double, character and BLOB(Binary Large Object) types of records. The binary conversion strategy for the GDMS can be concluded as following:

⋆ All binary conversion are transparent to users unless particularly specified.

⋆ Data record is stored in native binary format.

⋆ Conversion happens only when data is transferred between different platforms.

⋆ No conversion applied to character and BLOB data types.

6. DATA VOLUME AND OPERATION PERFORMANCE

The primary data source of this system is generated from NWP system on CRAY. CWB GLOBAL model forecast interval for 00Z is 72 hours, and for 12Z is 240 hours. The output interval before 72 hours forecast is 12 hours. After 72 hours, forecast output interval is 24 hours. The total Gobal output will occupy 680 MB disk space per day. CWB REGIONAL model is a nested grid model which will forecast to 72 hours for 00Z and 12Z. The output interval for coase grid is 12 hours, while that for the fine grid is 6 hours within 48 hours 12 hours after that. The disk space required for REGIONAL model is around 300MB per day. The acture access volume relied on the interaction between models and down stream systems is around as three to four times as the output volume, while the data access client can be on the FDDI ring or any where on the Ethernet network.

Table 1 shows the performance result from the testing which uses CRAY as a server, while various client on the network continuously access two hundred GLOBAL model grid. The measurement number in this table is the average from total wall time needed by each operation. The "Local" in table means the access test was done locally without using the NET module. The "Loopback" means the access test was done locally but do use the NET module (i.e. client-server at the same host). The "Client1" means the client is on FDDI network. The "Client2" means the client is on Ethernet network.

7. CONCLUSION

It has been half year since first GDMS version begin operation while continuous function enhancement and improvement are still on going. The preliminary result shows the stability and performance of GDMS can satisfied the data access requirement of daily operational forecast and down stream systems. Future direction of the work on GDMS will be put on the real time compression algorithm to reduce disk I/O and network transfer time. The support to very large sized BLOB record (few MB to tens of MB) will also be addressed to process the user defined data. More hardware and software platform support will be considered while available.

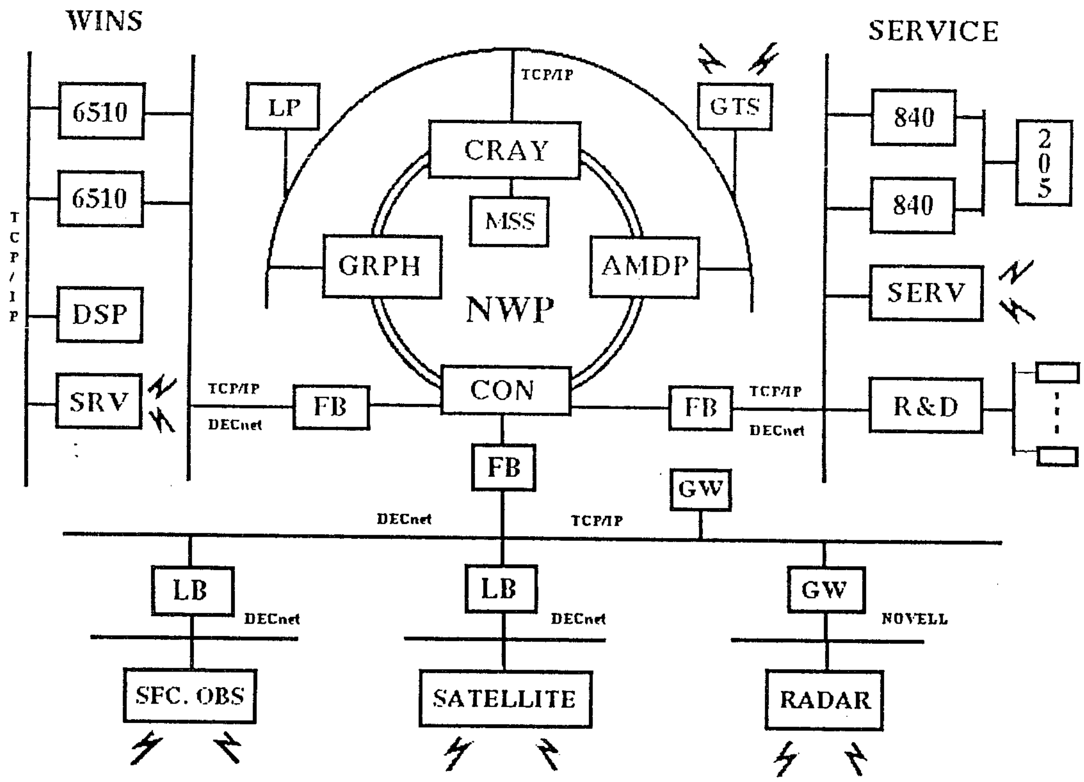

Fig.1 Central Weather Bureau network layout

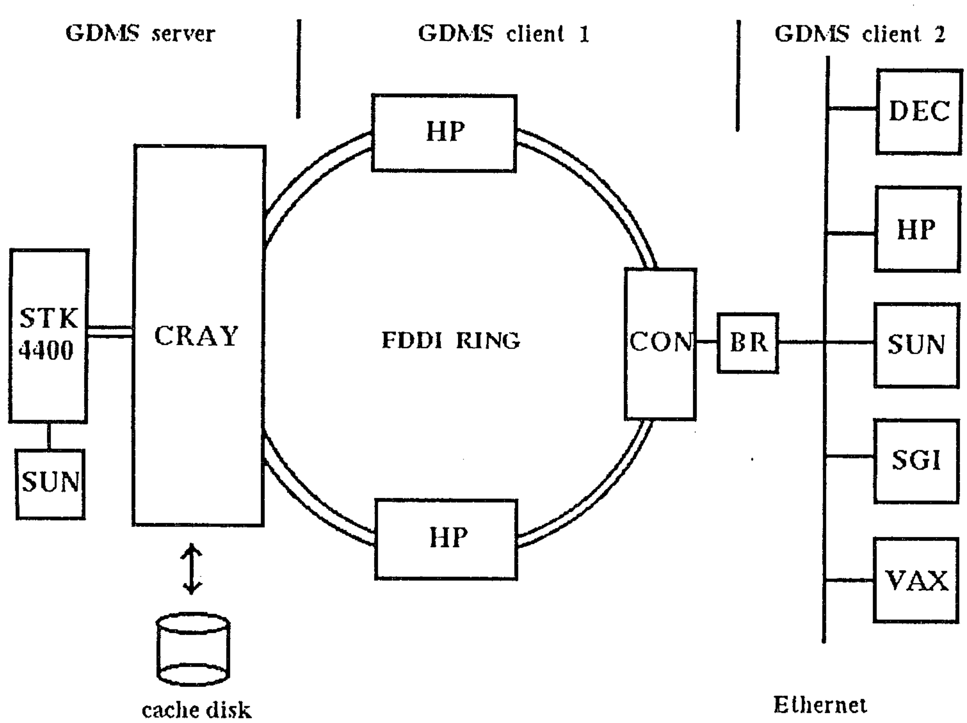

Fig.2 Operational data connection between GDMS server and client