ABSTRACT

The size of the Olympic Games has become enormous, and the amount of various information and communication produced in the Olympic Games has also been increased rapidly. So, we have developed an Olympic computer system GIONS (Games Information Online Network System) to support games management and to provide games information.

To enhance performance and reliability of the system, this system was developed by using distributed data processing technique which many other Olympic computer systems have not yet used. GIONS was also developed to provide interface with several other computer systems. GIONS uses DAS (Database for Application System) for the efficient providing of Olympic Games information. During the '88 Olympic Games, the system operated in a stable way and many people of various nations and organizations agreed that this system is excellent.

I. PREFACE

The Olympic computer system was introduced for the first time in the 1964 Tokyo Olympic Games. It was so small that it could be used only for match result processing. The computer system was in full scale use in the 1972 Munich Olympic Games. The SIJO (System Informatique de Jeux Olympique), developed and used for the 1976 Montréal Olympic Games, was also used for the 1980 Moscow and the L.A. Olympic Games. In the L.A. Olympic Games, especially, the computer system was in use for various fields from the games management to the supply management. But all those systems were centralized data processing systems. Hence, those systems cannot meet the increased requirements of '88 Olympic Games.

The requirements of the 1988 Seoul Olympic Games Computer System can be summarized as follows:

- Response time should be short
- A complete error-free system should be developed and radical back-up measure should be prepared
- Various information on athletes, records, officers, etc. should be provided quickly
- It should be developed in modular way in each sport for the convenience of maintenance in order to use the system for domestic sports events after the Olympic games are over
- The capability of efficient handling of update requirements shall be provided

On the other hand, the centralized computer system used for previous Olympic Games cannot meet the requirements stated above. So, the distributed data processing system which can satisfy the requirements above is developed. The main reason why we adopted distributed data processing system can be explained by its computer system capability aspects. By applying DDP to the Olympic Games computer system, we can get the following advantages.

- System efficiency improvement:
  Considering the fact that most data to be processed by computer are generated almost at the same time, it is more efficient doing multiple jobs by many local CPUs than doing one job by one CPU.
- System reliability enhancement:
  The 'distributed data processing system' in which many CPUs and peripherals operate interdependently can solve the instability problem
of 'centralized system'. It means, even if one or two systems incur a malfunction, other systems can complement their functions.

Modular system design:
System design can be simplified because the system control and function are dispersed by many regions. This concept is useful for the Olympic Games computer system when we consider the differences of operating standard among many sports events in the Olympic Games. Hence this system was developed in a modular way such that each sport system could be one independent system.

This paper describes the outline of GIONS system and focuses on its information retrieval system using database and interface design with other systems to improve reliability and system efficiency.

II. OUTLINE OF GIONS SYSTEM

The main objective of GIONS system development is to support excellent games management and to maximize games information service. To accomplish the objective, GIONS was developed as a distributed data processing system, provided electronic interfaces with several other systems, and provided statistics and progress processing. Now, with GIONS, we could provide fast and diverse games information in a stable way for various users of this system.

The GIONS network configuration is shown in Figure 1. The satellite node in the figure is used in two ways. One way is as a node of local autonomy which exchange information with master node. The other is as a node of remote terminal of the master node which only receives outputs from the master node. The small circle is for the latter function and the big circle is for both of the functions. Considering several
factors, such as node setting, node interconnection, and processing performance. IBM equipments were chosen for GIONS. The two IBM 4381s, master node computers, were installed in Olympic Computer Center (OCC). The relationship of two 4381 computers will be explained later. For distributed data processing by sports events, 47 S/36s were installed at venues. Each of the venue (except archery venue) has two S/36s, one is for back-up purposes. Figure 2 shows a typical hardware configuration of a venue system. The number of terminals and the size of S/36 hard disk are different from one another due to the difference of data amount, number of entry place and number of retrievals at each venue.

The software of the Olympic Computer System is designed in module by each sports event to provide information by summarizing them. The GIONS software consists of venue operating system and central operating system.

Venue Operating System

Each venue operating system (25 venues except soccer venue) has its own local autonomy and is modularized for each sport. In other words, there are certain modules which deal with corresponding sports events in each venue operating system.

- Games operation management subsystem
  The games operation management subsystem receives registration data from the host, prepares and manages registration data of judges and coaches and, and builds and corrects game files of each sport.

- Games result processing subsystem
  The game result processing is to generate start lists for games operations and to input game results into game progress. The status of a certain game can be retrieved at any place by providing game operation status, interim result and final result. This has not been provided at any other previous Olympic Games.

- Games statistics subsystem
  This subsystem provides various game summaries: team or individual game summaries for ball games, lap-time and game progress data for record games such as athletics and swimming. Many color graphics representing various statistics data are also provided.

- External interface subsystem
  External interface means the interface with the host computer. Venue operating systems send formatted output, game results and statistical data to the host.

- Electronic interface subsystem
  In some sports events such as athletics, swimming, equestrian, gymnastics and cycling, the venue operating system interfaces with timing & measuring devices to enter game result on on-line real time basis. In the Asian Games, only the swimming computer system had that capability but in the Olympic Games the other four sports computer systems also had that function.

Host operating system

Controlling satellite nodes, the host system processes basic data, summarizes information sent from venue systems to provide games information rapidly, and corrects and sends information to WINS, wire service, and TV, after reorganizing them.

- Basic data processing subsystem
  This subsystem processes participants registration, game schedules, and athlete information to support games preparation, start lists and games schedules for sports federations. This system also provides various registered information to the Olympic Organizing Committee, accreditation office, and olympic village.

- Games information processing subsystem
  This subsystem provides various games information rapidly and correctly: World record. Olympic record, athlete information, game schedules, start lists, games results, statistics, and color graphics.

- External interface subsystem
  This subsystem provides games information to WINS and interfaces with wire services and TV.

- Control management subsystem
  This control management subsystem monitors the whole system and is responsible for unexpected emergency situations.

Figure 3 shows inter-relationship of systems.
Figure 3. GIONS Context Diagram

III. Database for Application System (DAS)

Most of the database systems that were recently developed, are relational database systems. The relational database management system, however, cannot operate efficiently under certain environments like the Olympic Games. A database system for Olympic Games should have powerful capability of multi-user support with minimum response time. In the Olympic Games, press people and other users at each site want a database system which is easy to use and has powerful data access capability, and programmers want a database system which can process data easily and is easy for program modification. DAS is a developed database system which can satisfy these requirements, easily manage program modification, and utilize information resources efficiently by powerful query function.

DAS has a simple data expression, powerful access function, and high data independence because it is based on the relational database management system. DAS has a three-layer structure. Conceptually, DAS maintains data in tables, which internally consist of inverted files having actual record and field. DAS stores files and indices separately. Because this improves data independence, file deletion and new file creation do not influence other files. Record field, sub-field, or field group can be defined as keys and it need not modify applications even in case of key attribute change.

COBOL, PL/I can be used as a host language and HQL (Hangul Query Language) can be used for database query to access data. End user can use database interactively through terminal, and a user without special knowledge of database can access database in Korean, English and French by using high level database command without any particular assistance. DAS can be operated under MS-DOS and MVS/XA of IBM personal computer and IBM mainframes.

The minimization of input and output is one of the most important factors in improving database system performance. DAS provides buffer for this purpose. The input-output buffer in the virtual storage device enables multiusers to access to data and enhances input-output function for direct access. DAS adopts an index structure that can access all of the records with high performance and flexibility. DAS provides flexible access even for the keys which is not specially defined. Regardless of data type, the range searching and truncation searching are possible for any keys defined, and the sequential processing by key order is also possible. The complex boolean searching is also provided. DAS responds to user query in a minimum response time by choosing the optimal path in search.

The most complex and important thing in database management system is to maintain error-free data. DAS stores data according to data type of each field defined by internal scheme and sets range to each field value when data is inserted or modified. DAS also provides preparation function and recovery function to recover all errors occurring in data processing such as database error, H/W error, and communication error. For this, DAS provides not only forward correction function but also backward correction function, and provides
recovery function by transaction logging method. When error occurs, it provides emergency restart capability. For security, DAS allows only qualified systems and programs to access data and gives password to control access.

IV. INTER-SYSTEM COMMUNICATION

The interface in GIONS can be categorized into the following parts.

- Interface for system backup.

Even though every system needs a backup scheme, it is more urgent for the game operating system. This can be made by IBM 4381 - IBM 4381 interface, IBM 4381 - IBM 5382 interface, and IBM 5362 - IBM 5362 interface.

- Interface for automatic entry of games information.

For system performance and reliability, some venue operating system was developed to interface with electronic timing/measuring system. This can be made by PC/AT-IBM 5362 interface in athletics, swimming, cycling, equestrian sport, and gymnastics. DISAC 2000 - IBM 5362 in shooting, SR/305 - IBM 5362 in archery.

- Interface for games information transferring to other systems.

To provide various information generated in GIONS quickly and widely, several other service systems were interfaced with GIONS. AT&T 382/400-IBM 4381 interface provides information for VINS. Wire service host computer and NBC TV host computer were also interfaced with GIONS to receive games information from GIONS.

Out of the interfaces stated above, details on the interfaces of IBM 4381-IBM 4381, IBM 4381-IBM 5382, and IBM 5362 - IBM 5362 are described below.

Interface of IBM 4381 and IBM 4381

The host system of GIONS consists of IBM 4381 - R03 (system A) and IBM 4381 - R14 (system B). Figure 4 shows the relationship of the two computers.

This system is not designed in a way of one host computer for all application programs and the other one simply for backup. It is designed for system A to process entry applications and for system B to process retrieval applications, respectively with the communication capability of each other. So, in case of emergency they can backup each other. Therefore, this system can improve performance by virtue of workload distribution and can enhance reliability by preventing 'system down' that may be resulted in case of using only one computer.

It is possible to exchange information between applications by virtue of the connection of the two systems: loosely coupled H/W using CTC (Channel To Channel) and S/W connection in ISC (Inter System Communication) method. Only one terminal is necessary to access applications in the two systems to save terminals and communication facilities. The joint use of GIONS database by the two system reduces data redundancy and enhances data integrity. If one system develops malfunction during the operation, the other system will operate all application programs and all remote terminals will be connected to that normal system through a switch patch panel to minimize system-down time.

Interface of IBM 4381 and IBM 5362

The interface of IBM 4381 and IBM 5362 will be explained in three parts.
1) Games Information Transfer

SNUF (SNA Upline Facility), one of SNA/SDLC communication subsystems, makes interactive communication between IBM 4381 and IBM 5362 possible. Figure 5 shows this. After receiving confirmation from judge, the key and file ID of game result data are recorded in the log file of IBM 5362. Sender, always scanning the log file, attempts to send data not sent yet. For this, all processes commonly use same disposition to allow sender to read/write all accessing files. Monitor 1 is a program monitoring transfer status of all venues. Monitor 2 is a program reporting transfer status to operator. At every record transfer, the receiver feedbacks the result of IBM 4381 transaction to sender, and the sender automatically retries to transfer in case of communication error besides the application error. Therefore, the operator need not be concerned about the success of data transfer. In case of application errors, the host computer operator requests reatempt of data transfer from IBM 5362 at venue after removing error reported from Monitor 1. If the data transfer fails due to IBM 5362 application error, it automatically retransfers data after data supervisor at venue removes the error, which help to maintain transparency. CNN, subsystem of IBM 4381, inspects network status, stores and manages all communication status statistics such as line failure, and IBM 5362 damage.

2) Basic Data Transfer

All basic data (registration, schedule, best record) generated before the game start, are transferred from IBM 4381 to IBM 5362 through the IBM 5362 WSRJE (Multiple Session Remote Job Entry) facility. In other words, the IBM 5362 submit JES2 (Job Entry Subsystem 2) Job to IBM 4381 through RJE facility, then the Job transfers data necessary for each event to IBM 5362.

3) Backup & Recovery

An IBM 5362 in the computer system headquarter maintains all data of all venues generated until the previous day. If data recovery is impossible in a short time period, the corresponding data file of IBM 5362 at headquarter can be transferred to the venue through DSX (Distributed Systems Executive) facility.

As described above, there are two IBM 5362s at each venue. They are developed to be connected on online real time basis for automatic backup, so the secondary S/36 can recover data immediately in the case of primary S/36 failure. For this purpose, APPC (Advanced Program to Program communication) of SSP-ICF supported by S/36 are used. Fig. 6 shows this. In each S/36, the sender program and receiver program are loaded to exchange games information by record. The monitoring of this transfer status is also possible.

VI. CONCLUSION

The Olympic Computer System, GIONS, that adopts the distributed data processing concept has been described in general. However, all the
details could not be included in this paper due to the huge size of the system. After operating '88 Olympic Games with GIONS, the following conclusions were reached:

- The system operated in a stable way and no major problem occurred during the operation.
- The average time spent until the games result is finally distributed was about 5 minutes.
- The average system response time at terminal was 2 seconds.
- Various information was provided rapidly by conditional retrieval.
- The interface between GIONS and other systems was better than that of SIJO(L.A. Olympic Computer System)

Host people of various nations and organizations such as IOC, NBC, E&W, OCA, Peking Asian Games Organization Committee, Barcelona Olympic Organization Committee accepted that GIONS is an excellent system. This brings an opportunity to let the world know the high computer technology of Korea. There is a significant meaning in developing a distributed data processing system for international games for the first time.