A STUDY OF EXTENDED AND INTEGRATED DATABASE IMPLEMENTATION IN KOREAN ENERGY MANAGEMENT SYSTEM

Hyo Sang Lee — *lhs707@kpx.or.kr*
Wan Hong Kim — *wanhong.kim@kpx.or.kr*
Yeo Jun Yoon — *yjyoon@kpx.or.kr*
KPX (Korea Power Exchange), Seoul, Korea

Key words: Energy Management System, SCADA, real-time database, application common model, offline DB

ABSTRACT

Increasing the size and complexity of power system, the importance of EMS(Energy Management System) grows significantly. Implementation of efficient database is necessary for the EMS functions which are managing the massive and real-time data. This paper describes the most important and advanced structure of the integrated database in the process of developing KEMS(Korean Energy Management System).

I. INTRODUCTION

MOCIE(The Ministry of Commerce and Industry and Energy) of South Korean government opened the CBP(Cost Based Pool) power market which separates a generating portion by restructuring the existing vertically integrated power industry, and founded the KPX(The Korea Power Exchange) which takes charge of a power system operating section and a market operating section in April 2001.

KPX(Korea Power Exchange)

At the end of 2006 the Power market of Korea has the size[1] of installed capacity of 65,354 MW, daily trading volume of 972 GWh / $55 million, 73 generation companies and 1 transmission & distribution company(KEPCO).

This paper describes the most important and advanced structure of the integrated database in the process of developing the KEMS(Korean Energy Management System) which is necessary for KPX to operate its own power system.

II. DEVELOPMENT OF KOREAN EMS

A. Background of Development

KPX introduced 1979 ELD system, 1988 Toshiba EMS system and 2001 AREVA EMS system consequently for power system operation. Using the product of famous vendor has the strong point that it uses the product which is verified, but it also has the problem of maker subordination and high cost demand for maintenance, and the problem of impractical application of function followed by the lack of self-design ability.

KEMS(Korea Energy Management System) which is expected to solve those problems and can rapidly deal with the diversifying environment of power industry, is driven to be developed with academic-industrial cooperation since 2005.

B. Development Process

Figure 1 shows that KEMS is being developed thru the Baseline, the Prototype and the Fullscale phase for that it could be expanded in order.

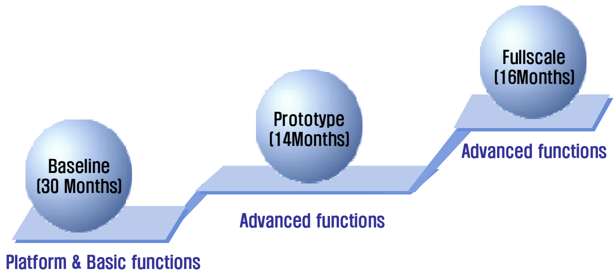

Figure 1. KEMS Development Phase

III. APPLICATION FUNCTIONS IN KEMS

The functions[2] in KEMS are similar to the general EMS functions, but they have some part of market operating functions to cope with hereafter power market change of Korea.

A. Supervisory Control and Data Acquisition (SCADA)

Data acquisition, data processing, remote control

B. Generation Application

Automatic generation control, economic dispatch, load forecasting, unit commitment, security enhanced economic dispatch, optimized generation schedule, market system interface

C. Network Application

State estimation, dispatcher power flow, contingency analysis, transmission loss factor, optimized power flow, voltage var dispatch, security enhancement, transmission transfer capability, outage scheduling

D. Information Storage and Retrieval

Periodic storage and retrieval of power system operation results, reporting system

E. Dispatcher Training Simulator

Power system state simulation, dispatcher training function

Figure 2 describes the application function structure of KEMS.

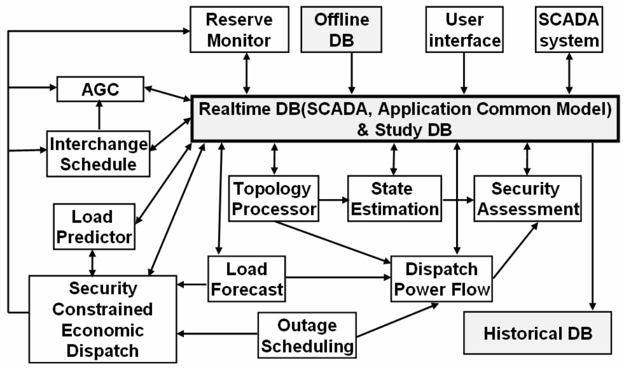

Figure 2. KEMS Function Structure

IV. STRUCTURE OF KEMS DATABASE

A. Structure Outline

The EMS, except the Study mode, typically manages the real-time data process based on the present power system model. Efficient composition of EMS database is required for that it could maintain the power system model information consistently standing the change of power system.

For this purpose, the database of KEMS is composed of Offline DB, Real-time DB, and Historical DB as shown in Figure 3.

B. Offline DB

Database change in EMS must be accomplished carefully, because one trivial error in database will be able to bring about the fatal result of EMS function process. The changed database should be applied only after the integrity is guaranteed by a verification process, and an Offline DB is used for this purpose.

Offline DB is used for the changing process (equipment addition into, elimination from power system model DB) in a server which is separated from the KEMS host. The convenient user interface is provided for the DB changing process.

Once the changing process is finished, Data are extracted from Offline DB, verified and populated into the real-time DB of KEMS host.

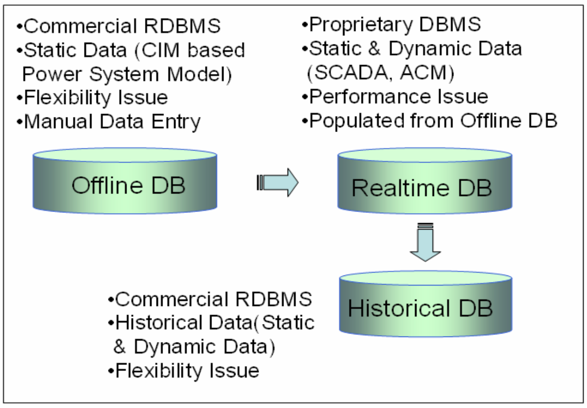

Figure 3. KEMS Database Structure

Offline DB is constructed based on the IEC 61970 CIM(Common Information Model)[3] after adding and modifying some data model by the necessity, and it used commercial RDBMS(Relational Database Management System) for the flexibility and convenience.

C. Real-time DB

The real-time DB is constructed inside the KEMS host for all the functions.

The real-time DB demands a fast data processing ability for that the functions of SCADA, generating application, network application, and etc. in EMS can manage the massive data in a very fast period (in a few seconds).

Normally, disk based commercial RDBMS is used for general IT systems, but the KEMS uses propriety technology based on main memory to satisfy the functions for the Real-time DB, instead of using commercial RDBMS. One of the reasons for using this kind of technology is that it is expected to solve the technical issue[4] which real-time DBMS has. It seems that major EMS vendor such as ABB, Areva don't use commercial RDBMS for their products[5] yet.

The real-time DB is logically classified with SCADA DB and ACM(Application Common Model) DB. SCADA DB is designed suitable for real-time data acquisition/monitor/control function, and ACM has the optimized structure suitable for processing the generation application and network application.

1) SCADA DB

SCADA DB manages the analog and discrete data received from the RTU(Remote Terminal Unit) and RCC(Regional Control Center). SCADA acquires about the analog and discrete data of 50,000 points remotely in a 2~4 seconds and it manages the calculation point of about 20,000. In SCADA DB analog, discrete table are located under the hierarchical structure of Company-> Area-> Division-> Station-> Equipment Type-> Equipment-> Telemetry in Figure 4.

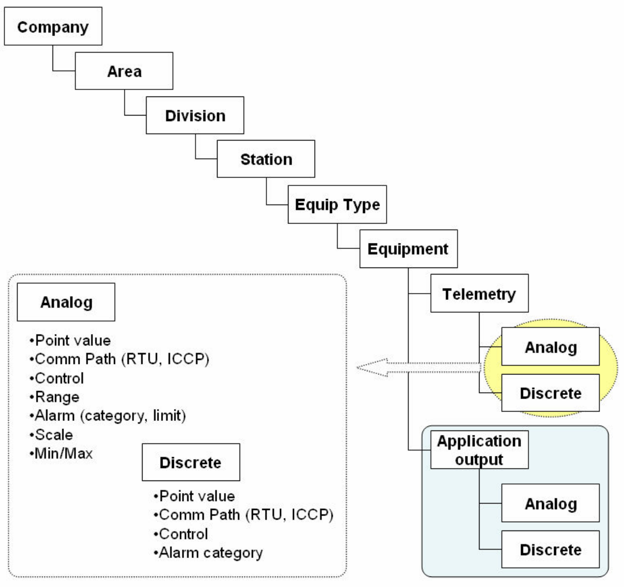

Figure 4. Hierarchical Structure of SCADA DB

Also, it includes the application output structure(analog, discrete tables) to display the result of power system application process on the oneline diagram and station tabular display.

2) ACM DB

ACM DB is that manages the commonly used data by more than one application, is designed for the structure of satisfying the application process speed. Most of the network applications should deal with the massive data in a short time, and many applications require and handle the same data simultaneously. In this environment, special DB design is needed for satisfying the application process speed and maintaining the integrity and consistency of the data as shown in Figure 5.

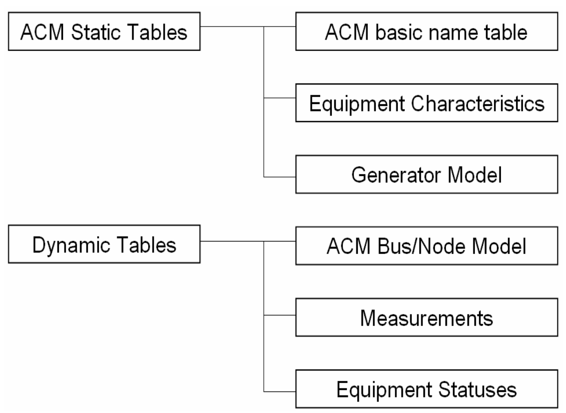

Figure 5. Structure of ACM DB

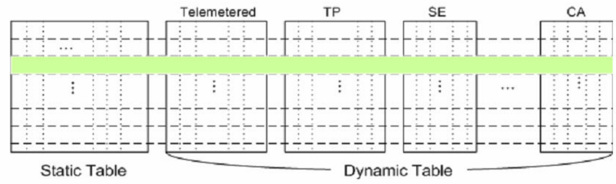

Figure 6. Separation of Dynamic Tables(Parallel Structure)

Each Power equipment attribute classified into the static data and dynamic data, and ACM DB is designed with static tables(static data) and dynamic tables(dynamic data) as shown in Figure 6. Static data can not be changed after being built when the KEMS start up. Dynamic data is being changed, as a SCADA telemetry value or a result of application process. Without complicated locking mechanism, integrity and consistency of ACM DB can be maintained by excluding mutual interference with the separated table for each application.

Also, it uses the branch/injection table which is designed for managing the branch equipment and injection equipment as a package to enhance the speed of processing the applications. Figure 7 shows the relations between branch/injection equipment, station, and CB based on bus.

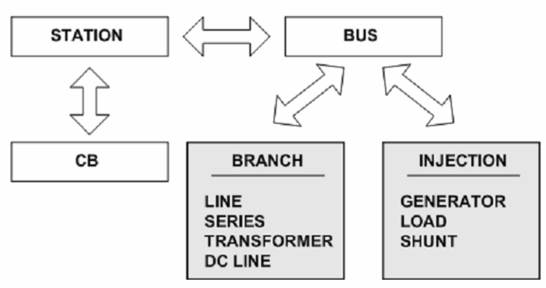

Figure 7. Structure of Branch/Injection Table

3) Study Mode Environment

Study mode assesses the reliability of power system by accomplishing the applications selectively in a different environment from real-time mode. KEMS has the DB environment in Figure 8 to support simultaneously both the real-time mode and study mode in a single server.

Study mode application reproduces the DB structure of real-time mode when it is initiated. It has an advantage that the study mode can reuse the applications or displays which were used by the real-time mode because of the same DB structure, while there is a burden in a host system of increased number of the reproduced study mode.

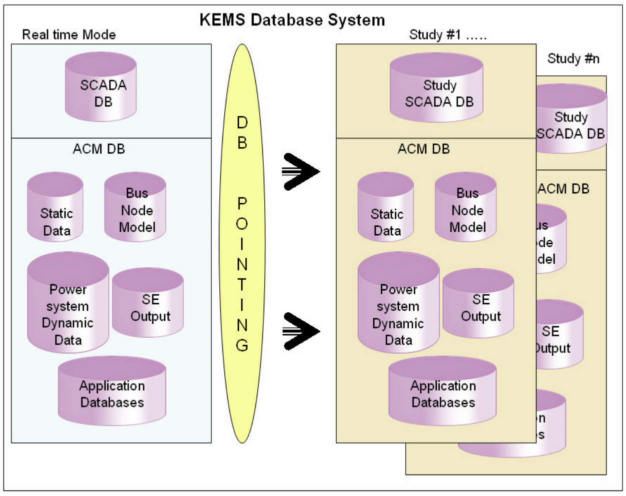

Figure 8. DB Environment for Study mode

D. Historical DB

Real-time DB which deals with the massive/fast real-time data has a hardship of long term data storage. There is a historical DB to store the data processed by KEMS in a long term.

Historical DB is located on a commercial RDBMS based server separated from the KEMS host, and periodically retrieves the real-time DB and store the data in its own DB. The structure of historical DB is shown in Figure 9.

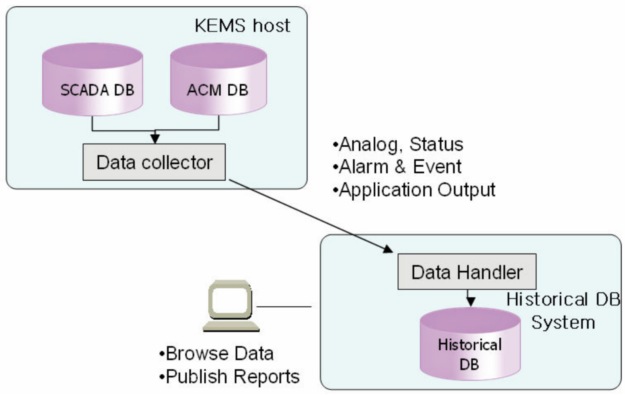

Figure 9. Structure of Historical DB

The data being stored in historical DB are analog, discrete information, alarm/event information, application execution results, and etc., and it has a storage term of one month to several years according to their importance and practical use.

The stored data in historical DB can be conveniently retrieved by and reported to back office affairs so they can analyze the operating results or use them for system operation planning.

V. CONCLUSION

Increasing the size and complexity of power system, the importance of EMS grows significantly.

A perfect and efficient design of DB is essential, for the massive real-time data process and accomplishment of many complex applications in EMS system.

The KEMS is classified as an offline DB, real-time DB, historical DB, and etc. by the maintenance purposes, and designed SCADA DB and ACM DB by the needs of applications.

Thorough the integrated and extended database environment of KEMS, it is expected that the SCADA, generation application, and network application will mutually articulated and give the optimized performances.

VI. REFERENCES

1. Korea Electric Power Statistics Information System (KPX, http://www.epsis.kpx.or.kr)
2. KEMS Technical Specification (KPX, 2005)
3. CIM Vers.10 rev.7 (http://www.cimuser.org, December 2005)
4. Jian Wu, Yong Cheng, and Noel N.Schulz, “Overview of Real-Time Database Management System Design for Power System SCADA System”. *SoutheastCon, Proceedings of The IEEE,* pp. 62 – 66, March 31 - April 2 2006
5. “Network Management SCADA/EMS Product Plan”, Neela Mayur, ABB, June 2005 / “EMS Roadmap AREVA T&D Automation Systems”, Thierry Godart, Ph.D, April 2006.