

BMA's INFORMATION SYSTEMS INTEGRATION PLAN: DATABASES*

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Abstract: *Information system (IS) planning is one of the most significant activities for IS acquisition in a large organization. The paper presents the planning of IS integration plan of Bangkok Metropolitan Administration (BMA) in database aspects. The main objective of this IS integration is to specify techniques to link all databases in BMA so that information is interchanged among them seamlessly. The plan was accomplished by applying the methodology consisting of three steps: review and analysis, conceptual design, and final report documentation. As the results of design, all databases share some identical data items, of which information update in batch processing is enough. Thus, database replication and application-program-interface (API) are recommended to implement for databases with identical and different database management systems, respectively. In addition, a concept of data warehouse is recommended for implementation to provide summarized information for BMA's management.*

Keywords: *Information Systems, Information Technology Planning, Systems Integration, Database Design, Data warehouse*

INTRODUCTION

Bangkok Metropolitan Authority (BMA) has responsibilities to provide various services such as census records, education, public cleansing, health, etc. to all people who live in Bangkok. To provide services with high efficiency and quality, BMA has introduced various technologies to support day-to-day operations, management's decision-making, monitoring and control, etc. As examples, management information systems (MIS) have been developed to support administrative works, Area Traffic Control (ATC) has been implemented to monitor and control road traffic, etc. Because BMA is a large organization having various responsibilities, thus, BMA has numerous departments and district offices taking care jobs in different functions and areas. Each department/district office is allowed to organize, direct, and control its strategic plan, operational functions, and budget independently. Consequently, the degrees of applying information technology for each responsibility unit are different. In addition, the more serious problem is that standards of technology used in the application systems are different. As examples, while MIS has the host-based data-processing architecture with Oracle database engine, the information system supporting operational functions for 50 District Offices has the client/server architecture with Informix database engine. In fact, there are some data items being shared between both systems and applications. Thus, integration of all information systems in BMA, so that they interchange information seamlessly and provide the single-system image to users, is very significant.

This paper presents the summary of BMA's information system integration plan (ISIP) done by the consultant team of Assumption University. The ISIP project started in December 1998 and finished in June 1999, and covered 20 IS projects. Those projects are classified into 3 categories: ISs under operations, ISs under acquisition and development, and other relevant ISs. The ISIP was

* This project was done under the contract between Bangkok Metropolitan Administration and Assumption University.

accomplished by applying the methodology consisting of 3 processes: review and analysis, conceptual design, and final report documentation. The review and analysis process is conducted so that all ISs under scope of work are understood in details. The ISs are studied in 2 aspects: database structure and computer architecture, of which the part of database is presented in this paper. The results of database analysis are used as basis of the design process. In the ISIP, only conceptual design is done, i.e., the logical configuration of database interconnections and technological standards are specified. Then, the managerial information, such as implementation priority and budget, is added to document the final report.

As the results of analysis, all databases share some identical data items, of which information updating requires only batch processing. Thus, database replication and application-program-interface (API) techniques are specified for integration of databases with identical and different database management systems, respectively. In addition, the data warehouse, in which all significant data for management is collected and stored in the meaningful format, is recommended to be implemented to support management decision-making.

SCOPE OF WORK

Currently, BMA has a few information systems that have been already implemented and are under operations. However, there are numerous projects that are under the acquisition and design processes. The integration plan covers all current IS projects in BMA which can be classified into three categories:

(1) Information systems under operations. These systems are currently operated to support day-to-day operations of BMA, i.e.

- Management information system (MIS Phase I)
- Census and personal identification card information systems
- Information system for Phayathai District Office
- Complaining information system
- Document image processing system
- Computerized information system for hospitals of Medical Service Department
- Executive information system (EIS Phase I)

(2) Information systems under acquisition and development. These systems are during the acquisition and development processes, i.e.

- Information systems for Health Department
- Information system supporting operational functions for 50 District Offices
- Information systems for Public Works Department
- Information systems for Drainage and Sewerage Department
- Information systems for Public Cleansing Department
- Information systems for Community Development Department
- Information systems for Traffic and Transport Department
- Information systems for Budgetary Office
- Decision support system
- Computer systems for teaching support in schools of BMA
- Geographic information system (GIS)

(3) Other relevant information system projects. These projects are proprietary systems designed to meet the specific purposes, i.e.

- Flood protection system
- Area traffic control (ATC)

However, information systems in (3) have main objectives to monitor and control flood and road-traffic in Bangkok area, data is collected and processed instantly. Those systems have not stored any historical data for future uses like business-information systems in both (1) and (2). Consequently, the paper presents only database analysis and design of (1) and (2).

METHODOLOGY

The IS integration plan was executed by the consultant team of Assumption University. The team consists of specialists in various areas: project management, information system analysis and

design, database design, computer networks, etc. The project was accomplished by applying the methodology having three phases:

Phase 1: Review and analysis. In this step, the existing information systems being under operations and during acquisition processes are investigated. The study is conducted in two aspects: 1) program and data structures, and 2) computer architecture and networks. For program and data structure analysis, relationships among database tables (files), and between programs and the corresponding database tables are extracted. The database tables are clustered into groups, in which for a particular group the tables have tight relationships with each other and loose relationships with others in another groups. In addition, data items shared among databases of different systems are identified and then classified into various types. For computer architecture analysis, system configurations and network topologies are studied. The study results are used as basis information in the next phase: conceptual design. The information required in review and analysis phase of IS projects is collected from analysis and design specification documents of the projects.

Phase 2: Conceptual design. The objectives of this step is to conceptually design a configuration of databases and computer networks integration, so that information can be interchanged seamlessly and overall systems have a single-system image to users. The design is done on the basis of distributed computing architecture. This is because BMA is a large organization and has distributed management strategies, for which centralized processing architecture is improper. In this design, only a logical configuration of database integration, conceptual techniques of database access, and technological standards to be used are specified.

Phase 3: Final report documentation. In this step, the conceptual design specification report in Phase 2 is extended with managerial information such as implementation plan, investment plan, human resources development, IS management organization, etc. to be the final report.

Together with the submission of the report in each phase, the conference presenting the findings, designs, and recommendations is organized to ensure the project being executed properly.

DATABASES ANALYSIS

Nowadays, Bangkok Metropolitan Authority has implemented numerous computerized information systems to enhance the service quality and efficiency for Bangkok people. Such systems range from a transaction-processing system, which supports operational staffs on day-to-day basis jobs, through executive information system, which analyzes and provides valuable information to support management decision making. Thus, it is necessary to study all current information systems being operated and information system projects to be implemented in the future. The methodology described was applied by separation of information systems analysis and design into two aspects: 1) program and data structures, and 2) computer architecture and networks. The databases were analyzed by investigating the relationships among tables (files) so that they can be clustered into numerous groups. The following describes the results of review and analysis of programs and data structures.

Management information system (MIS Phase I) MIS Phase I is a transaction processing system, that was developed to support day-to-day operations in seven functional areas: fixed asset management, personnel management, accounting, finance, budgetary management, revenue management, and procurement management. The MIS Phase I has a host-based processing architecture, which application programs are executed by and databases are maintained at the central server (SUN Enterprise 3000). The application programs were developed by Oracle Form-3 and COBOL, and the database management system (DBMS) is Oracle version 7.3.2.

As the results of database analysis, there are totally 474 relational tables (files) which can be clustered into 58 groups. However, each subsystem gets access only to its own particular groups, not spread through all groups. As an example, the fixed asset management subsystem normally accesses only its own 3 groups: inventory control, gasoline control, and asset management.

Census and personal identification card information system. This system is developed to improve the services to people dealing with census records and personal identification cards. The architecture of the system is client/server, of which the application software runs on MS-Windows at client terminals and the Oracle database is maintained at the server running UNIX operating system.

Unfortunately, this system is under control of the Census Office, the Ministry of Interior, so that its database structures are not revealed.

Complaining information system. This system is developed to record and maintain complain information and to track the corresponding actions of responsibility units, so that all complaint is responded rapidly and properly. The complaining information system is operated under the identical server and networks of MIS Phase I. The complaining database has totally 23 tables with another 6 tables from MIS Phase I. Those 23 tables are clustered into 3 groups: complaining data containing 10 tables, incident data containing 9 tables, and rescued equipment data containing 4 tables.

Information system for Phayathai District Office. This system has been developed to support day-to-day operations at Phayathai District Office in seven main functions: public cleansing, public works, education, community development, health, city law enforcement, and government. The architecture of the system is client/server, of which the operating systems of client terminals and server are MS-Windows and UNIX, respectively. The database management system is specified to be Oracle DBMS, so that data is shared seamlessly with the Census Information System. As the results of analysis, the overall 171 relational tables are clustered into 33 groups. Tables in each group are tightly related to each other internally, while they are weak tied with others in another groups. This design provides database modification to be done in an easily manner.

Document image-processing system. The objectives of this system are to archive and retrieve information in the format of image data, so that proper documents can be searched and retrieved in an effectively manner. The system is mainly used in the Policy and Planning Department, because most of jobs are concerned with vast amount of data and document. This system has a client/server architecture, of which the server is UNIX platform. The document image-processing system has maintained data in 2 categories: textual data in relational database format and image data in image file format.

Hospital information system. This is an information system by the Medical Service Department. The system was developed to support day-to-day operations of the hospitals under administration of BMA. The architecture of the system is host-based processing, of which database management system is Ingres. There are totally 323 tables, which are clustered into 24 groups. However, BMA has only the license of executable programs, then it is necessary to acquire maintenance contract every year for software enhancement. It is recommended to initiate a new project to develop new programs, so that BMA owns source programs and reduces maintenance budget in long terms.

Executive information system (EIS Phase I). This is only a part of executive information systems to be developed in BMA. EIS Phase I was designed to support management in 4 functional areas: revenue management, budgetary management, personnel management, and asset management. All data is collected and summarized from the database of MIS Phase I. The system was developed by using Oracle Express. However, EIS Phase I has not been yet used by management because the database of MIS Phase I is still incomplete.

Other information systems. These information systems are currently under either development or acquisition processes as indicated in (2). Then, analysis was accomplished by investigating only the design documents of consultant teams. The followings are found from analysis of those information systems:

- each system is client/server architecture, of which the database is centralized in only the database server of each system,
- most systems have maintained some data items redundantly with the database of MIS Phase I,
- there is not any technical specification for interconnecting those databases.

CURRENT DATABASE CONFIGURATION

Figure 1 shows the logical configuration of current databases in BMA. It is indicated that the databases are distributive throughout BMA. Analysis of database structures in BMA has revealed the following matters:

- each department/district office maintains its own database,
- there are some data items redundantly maintained by every information system,
- duplicate data items among databases are classified into 3 types:

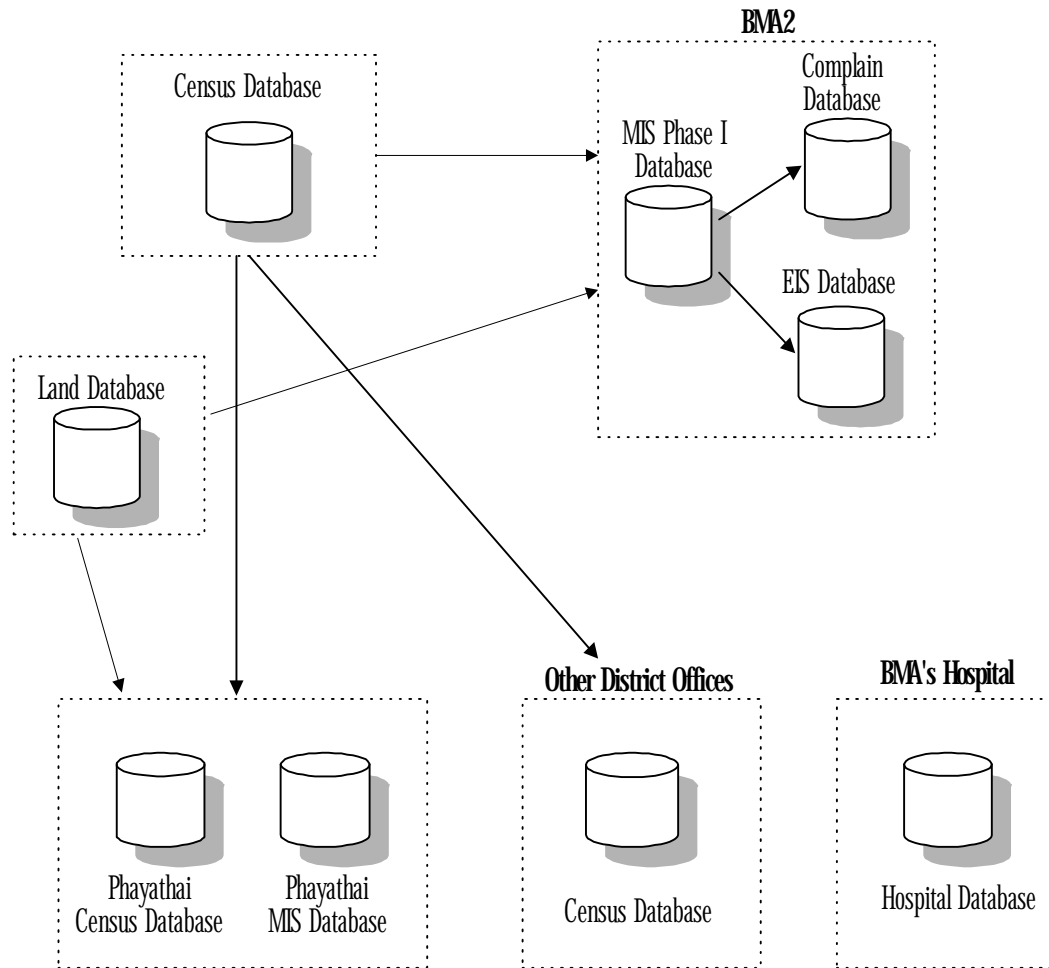


FIGURE 1 CURRENT DATABASE CONFIGURATION IN BMA

- master reference data from external data sources (MED)
- master reference data created internally (MID)
- transaction data created by various departments (TDD)
- those duplicated data items have been already created in the database of MIS Phase I,
- information update process among databases with duplicate data is not time-critical although it is transaction data.

Table 1 shows some significant data items maintained redundantly in various databases. As indicated in Table 1, data-items redundantly stored in databases are mainly MED and MID data types, which are rarely changed. In addition, transaction data, when it was created/changed, is not necessary to be updated immediately to other databases by its nature. Then, only batch processing for updating information is sufficient.

DATABASE INTEGRATION DESIGN

Integration of all existing databases in BMA was accomplished by taking the findings described above into consideration. In addition, there are some design-rationales:

TABLE 1 EXAMPLES OF DATA REDUNDANCY IN BMA

Data Redundancy with Census Database

Data	Subsystem
PROVINCE AMPHUR DISTRICT PREFIX PRESON HOUSE	MIS Phase I Revenue Subsystem Master Reference Data PROVINCE AMPHUR DISTRICT PREFIX Phayathai Information System PRESON HOUSE

Data Redundancy with Land Database

Data	Subsystem
LAND_OWNERSHIP LAND_TRANSFER LAND_ADDRESS_TRANSFER	MIS Phase I Revenue Subsystem Master Reference Data LAND_OWNERSHIP LAND_TRANSFER LAND_ADDRESS_TRANSFER

- master reference data must have the identical standard,
- there must be only one responsibility unit taking care of the master reference data,
- physical locations of databases should be close to users,
- techniques for updating databases among various departments depend on requirements of up-to-date information.

Consequently, the logical configuration of BMA's database integration has the following specifications:

- the architecture is a distributed database,
- each department/district office maintains its own database at the operating site,
- master reference data (both MID and MED) is maintained in the central database (MIS Phase I) and in local databases at user sites, and is updated with a central-to-branch method by batch processing,
- transactional data is maintained at the user sites and in the central database (MIS Phase I), and is updated with each other by batch processing,
- information updates with batch processing depend on whether database management systems (DBMS) between source and destination databases are different, e.g., database replication and application program interfaces (API) are recommended for identical and different DBMS, respectively.

Figure 2 shows the logical configuration of BMA's database integration.

DATA WAREHOUSE

This part provides recommendations of the consultant team to BMA about an information system for supporting management's decision making. Nowadays, a data warehouse has been conceded that it is a practical way to collect, process, and represent valuable information to support management's decision-making. It is truly a warehouse of data, in which management could find any information that is prepared in various subjects. While an operational database maintains information

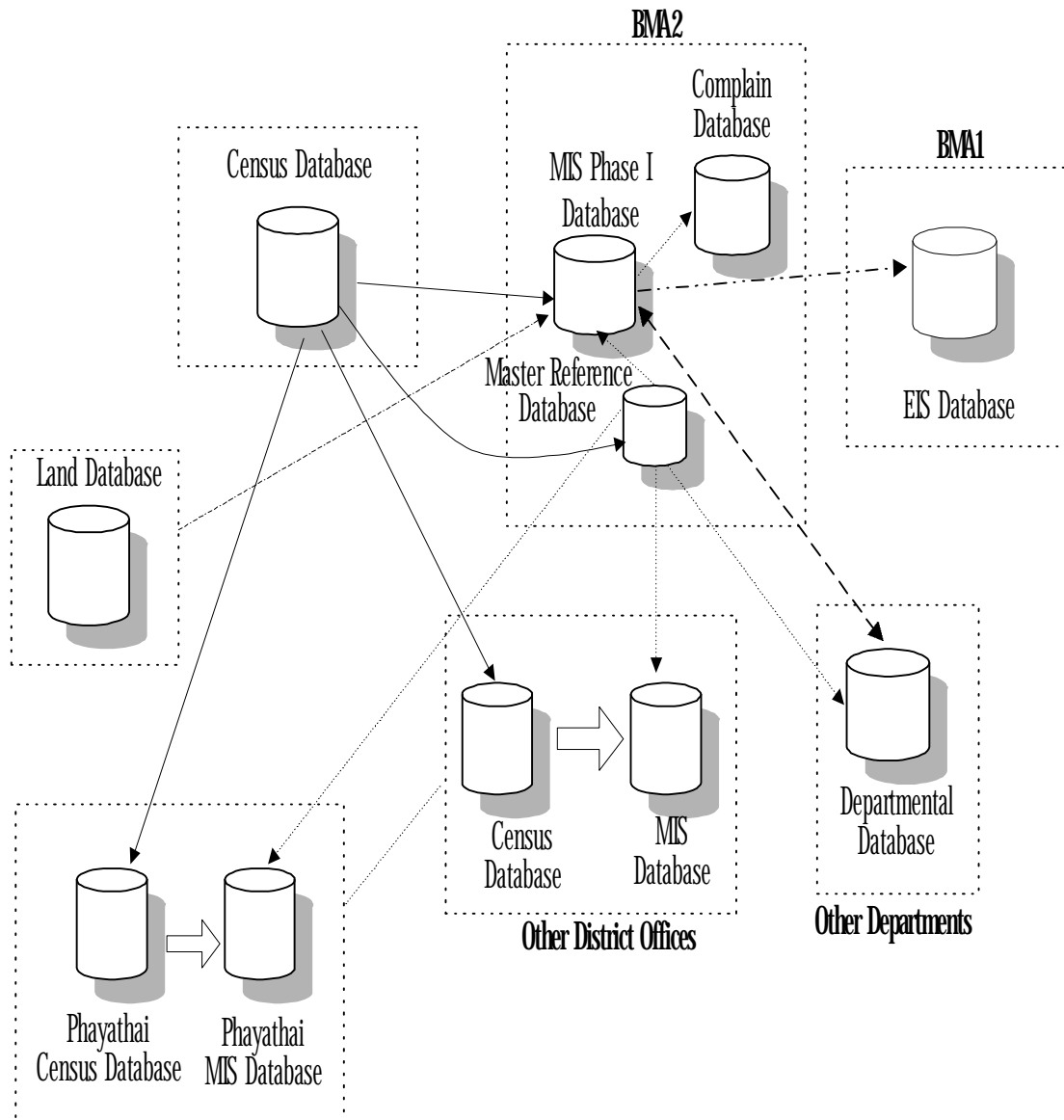


FIGURE 2. LOGICAL CONFIGURATION OF BMA'S DATABASE INTEGRATION.

by functional areas, e.g., marketing, finance, a data warehouse maintains information according to subjects, which integrate and summarize data from various areas. However, requirement specification of data warehouse is beyond the scopes of the project. The consultant team only recommends the configuration of data warehouse, of which a developer must perform detailed specification and design. Figure 3 shows the configuration of data warehouse in relations with other databases in BMA.

BMA's data warehouse in Figure 3 has the following considerations:

- the processes of data loading, cleansing, and transformation are done at BMA 2 (Din Daeng), because it is the center of all databases,
- the data warehouse at BMA 2 transfers data to the data warehouse at BMA 1 via scheduled batch processing with database replication technique,
- data warehouses at BMA 1 and 2 are remote backup to each other.

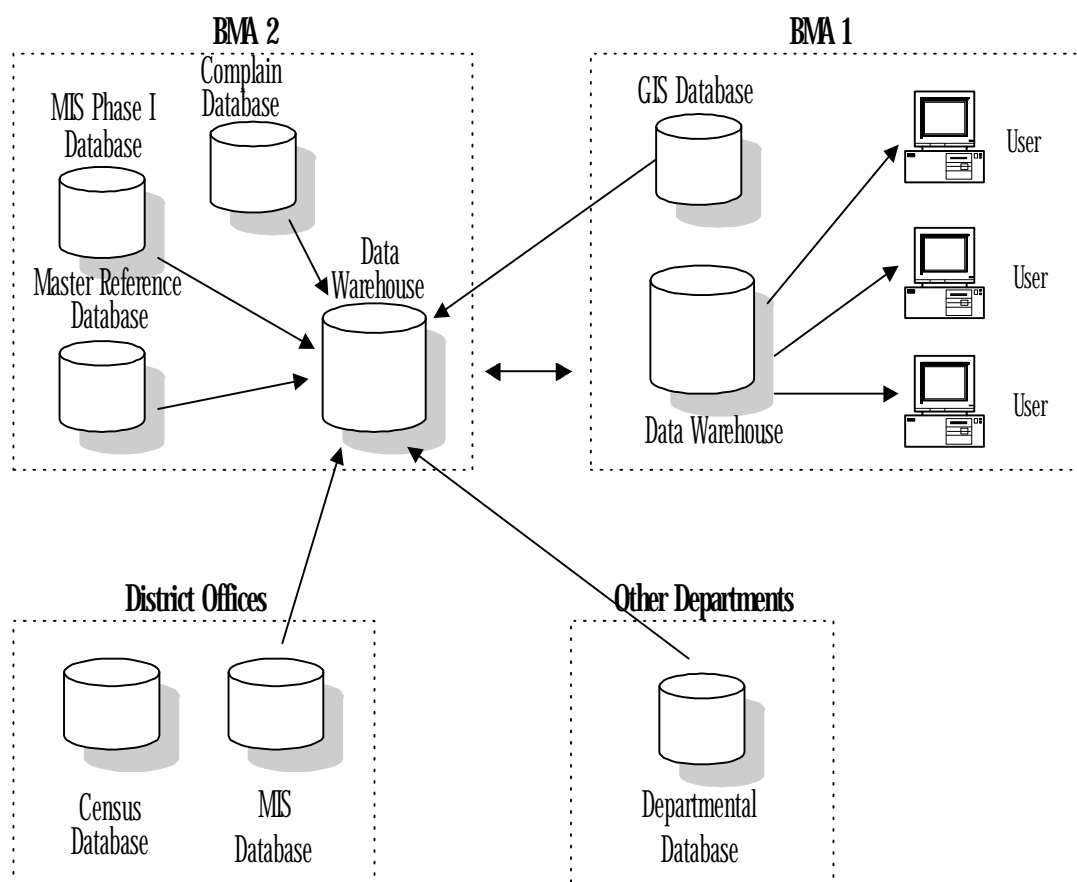


FIGURE 3. CONFIGURATION OF DATA WAREHOUSE IN RELATIONS WITH OTHER DATABASES IN BMA

CONCLUSIONS

The paper presents summary details of database integration, a part of information system integration plan of Bangkok Metropolitan Administration. The consultant team has applied a methodology consisting of three steps: review and analysis of current information systems, conceptual design of database integration, and final report documentation. The plan covers the most significant 20 information system projects in BMA. Those information systems are investigated in 2 aspects: database structures and computer system architecture. The results reveal that, for a particular information system, the database can be clustered into several groups. Tables in each group are tightly related to each other, while they loosely relate to a few tables in other groups. In addition, data maintained in a database can be classified into 2 types: master reference data and transaction data. Each database maintains both types of data redundantly at some degrees in order to provide database access in an efficiently manner to users. However, to maintain database integrity among databases, batch processing for database update is appropriate because most data is not time-critical. In addition, a concept of data warehouse is recommended for implementation to provide summarized information for BMA's management.

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