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Specialist Manager

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Specific Responsibilities

Joined Tohoku Information Systems Co., Inc. in 1983.

Currently, Specialist Manager in Electric Power Business Division System Development Group.

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Past Experience

1992-1995: Project Manager, Power Transmission Line Evaluation Support System Development

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1999-: Project Manager, GIS Platform Development.

Educational Information

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Masahiro Ooba
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Specific Responsibilities

Joined Hitachi Software Engineering, Co., Ltd in 1992.

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Past Experience

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Educational Information

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Joined Hitachi Software Engineering, Co., Ltd in 1972.

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Past Experience

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Educational Information

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Joined Hitachi Software Engineering, Co., Ltd in 1981.

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Past Experience

1991-1994; Supervisor, Hitachi Software Engineering America Ltd. Responsible for development and marketing for GIS software.

1994-1996: Manager, Hitachi Software Engineering Co., Ltd. Information and Image System Department.

1996-1998: General Manager, Hitachi Software Engineering America, Ltd. Responsible for CAD/GIS business for USA.

1998-2000 : President, Hitachi Software Global Technology Ltd.

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Educational Information

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GIS ARCHITECTURE AS A BASE OF ENTERPRISE INFORMATION SYSTEM AND ITS IMPLEMENTATION

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ABSTRACT

Recent IT developments allow organizations to overcome barriers to GIS including implementation and maintenance costs. Data and services standards are defined by industry/user groups. However,

these standards appear imprecise to meet large-scale enterprise system needs. This paper describes the implementation of Tohoku Electric's enterprise GIS; exploring options and solutions to realize open enterprise GIS. The main points are common GIS functionality, specific applications, flexible security, common base map, and legacy data interface. This architecture enables horizontal enterprise GIS and provides substantial business redesign.

1. Overview

Development and maintenance costs have traditionally been huge barriers to introducing new GIS systems. Recently, the rapid progress of information technology is starting to overcome these cost issues. At the same time, industry standards for geospatial data and GIS services are beginning to be defined by various user/vender organizations. However, these standardization efforts are not yet enough to construct real large scale integrated GIS system.

In this paper, we will discuss strategy and options for developing large-scale enterprise GIS systems in real business environments by describing the implementation of an integrated GIS system at Tohoku Electric Power Co., Inc, Japan (Tohoku EPCo). This is based on the project called "GIS Platform" in Tohoku EPCo, developed by Tohoku Information Systems Co., Inc., subsidiary of Tohoku EPCo, and Hitachi Software Engineering Co., Ltd.

The important concepts in this paper are: standard object handling components, business object management databases, legacy database connections, flexible security structure, and common digital maps. At Tohoku EPCo, remarkable business innovation is being realized by this integrated system based on the architecture described here.

2. Background

In response to the recent severe economic situation in Japan, the introduction of advanced enterprise information systems such as web services is being emphasized. Under such circumstances, it is getting popular to use geographic information as a service providing tool with detailed real world information such as customer account data.

In Tohoku EPCo, there have been strong and broad needs for GIS technology for such purpose as to extract information from visualized objects, to identify the status of a facility or customer for each area, etc. However, due to the high cost of digital maps and hardware/software for GIS, it was traditionally applied to only limited (and highly specialized) areas of the business.

Also, sharing data and information is essential for efficient facility management and better customer service for Tohoku EPCo, especially because of its extensive business area (7 prefectures covering 10% of the total population of Japan.) But since its information system was tied to each function or each business division, it was difficult to share the data or common function, especially if GIS technology was applied. (For example, one operation may have required updating different databases tied to different

systems.)

Considering the trend toward deregulation in the Japanese electric industry, it was inevitable to continue to reduce the cost of facility management or to improve customer service quality. To realize these goals, it was necessary to increase efficiency by sharing data and information systems among different business divisions. The construction of a data management infrastructure covering the entire Tohoku EPCo enterprise was vital to dealing with important issues such as centralization of management, expanding business territory, and out-sourcing management.

Under the circumstances of rapid price reduction of software/hardware/data (especially the price of digital maps), Tohoku EPCo decided to start a project to build an integrated GIS system as a common data platform. It was called "**GIS Platform**".

3. Overview of GIS Platform

GIS Platform plays the role as infrastructure for building a common business GIS application in Tohoku EPCo.

3.1 "GIS Platform" concept

In designing *GIS Platform*, the following five points were emphasized for quick application development and promotion of data sharing:

(1) Standard Object Handling Component

Providing systematized component set necessary for business application development, based on analysis of GIS related tasks in Tohoku EPCo. This includes:

- Common GIS functions
- Facility (management, design, maintenance) related functions
- Sales related functions
- System administration functions

(2) Business Object Management Database

Creation of business objects corresponding to actual physical facility

(3) Legacy Database Connection

Providing connection to existing business databases managed by each business division without data conversion.

(4) Security Management

Defining flexible security based on the role for each business object.

(5) Common Digital Map Data

Providing map database covering the entire business territory of Tohoku EPCo. Large scale/high quality map data (1/2500) was prepared for various needs of the business application.

In addition to the five points described above, the following policies were used to design the system:

- Definition of unified application development procedures to reduce the application development and maintenance costs
- Centralized server structure to reduce maintenance cost of the system
- Assurance of appropriate performance for heavy transaction traffic and scalability for future expansion
- Open system architecture to prepare for technology and standard trends in future

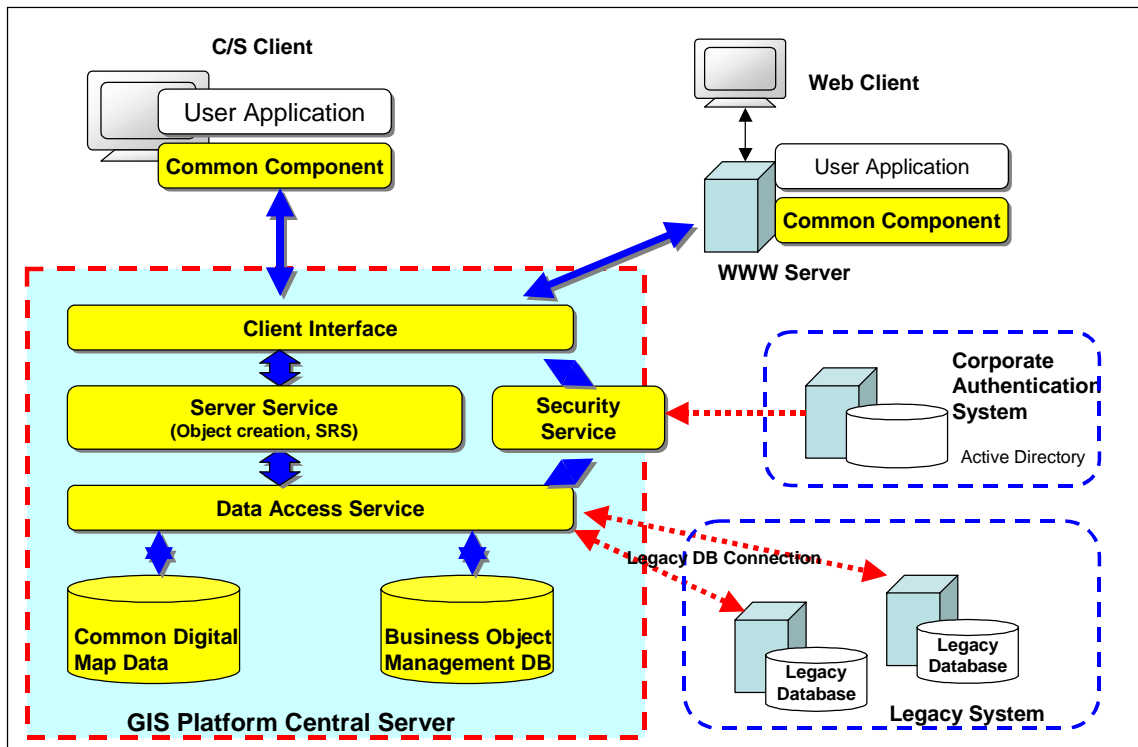


Figure 1: GIS Platform Concept

3.2 Implementation of each concept

(1) Common Object Handling Component

In *GIS Platform*, it was necessary to handle various electric power industry GIS applications. To define basic components systematically, the team first performed a business process review. Each component was defined based on the categorization shown in figure 2.

Common Object Handling Component consists of Command/GUI combination and application interface. The benefits of defining such components for every business area are:

- constructing GIS application system at low cost
- creating a unified application development process that brings stable quality and ease of transferring application development skill.

Common Object Handling Component was implemented by Java™ so that the resulting product was platform independent.

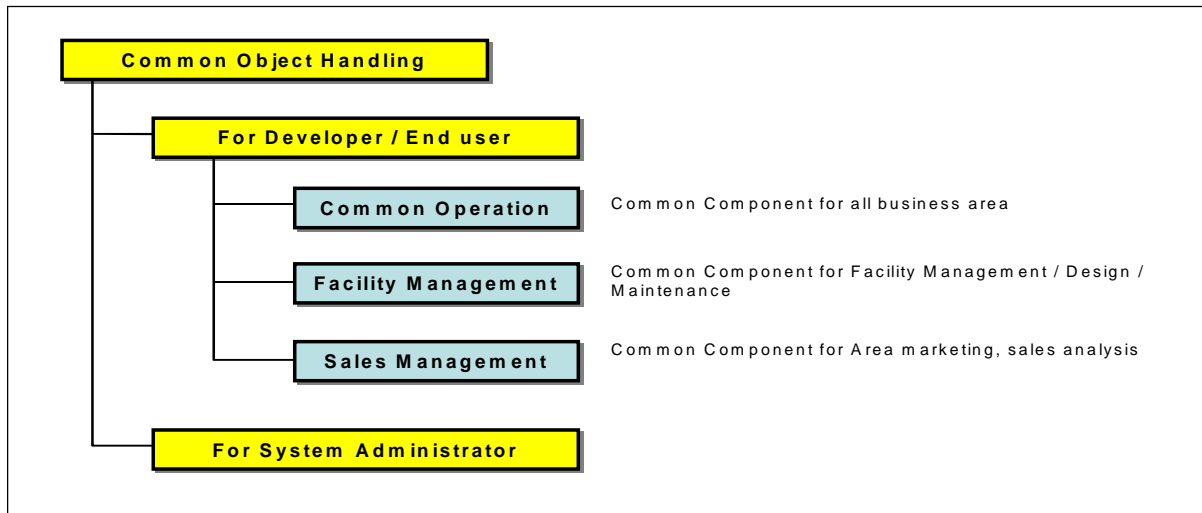


Figure 2 : Common Object handling Component

(2) Business Object Management Database

In *GIS Platform*, to manage all data used for business application, business objects were defined and stored in a commercial database management system.

- For each physical facility (such as electric pole), a business object (consists of geometry and property) was defined. Each business object formed a different layer.
- Each layer was implemented as a database table and stored to RDBMS (Oracle).
 - Geometry format was based on OpenGIS standard.
 - Property for specific application or division (such as client information) was not stored as a part of Business Object. Instead the key to external database was stored, allowing independent management of such specific information
 - Spatial index was defined for stable searching performance.
- The distribution facility was defined as Business Object, and all users could access it. It was called Common Thematic Object Database.
 - Approximately 2 million poles and electric lines (high voltage / low voltage) connecting these poles were managed.
 - It was defined as replica of Distribution Division database and updated nightly by batch process.

The benefits of defining such Business Object Management database are:

- i) Expandability by using Object Model
- ii) Better data security by unified management using commercial database system

(3) Legacy Database Connection

In *GIS Platform*, a Business Object Management Database was newly created. But it was also possible to use various legacy databases. Prior to beginning the *GIS Platform* project, Tohoku EPCo had developed and was maintaining several business application systems. It was important aspect of *GIS Platform* to inherit these past resources and allow integrated use with *GIS Platform* system.

Following is implementation detail.

- It was possible to integrate legacy database to GIS by simply defining meta-information necessary to describe the legacy database. Meta information consists of Access method to database, Name of table, column information Object definition for *GIS Platform* etc.
- In *GIS Platform*, access to all data resources was done by Data Access Service. For legacy database access, Data Access Service selected data access component based on the meta-information. Access component can be either JDBC or CORBA, or it is possible to add a new method in the future.

The benefits of legacy database connection are:

- Integration of existing database to GIS system without modification
- Transparent access to legacy database from *GIS Platform*
- Better data maintainability for future updates. It is possible to switch from legacy database to new database by just modifying meta-information.

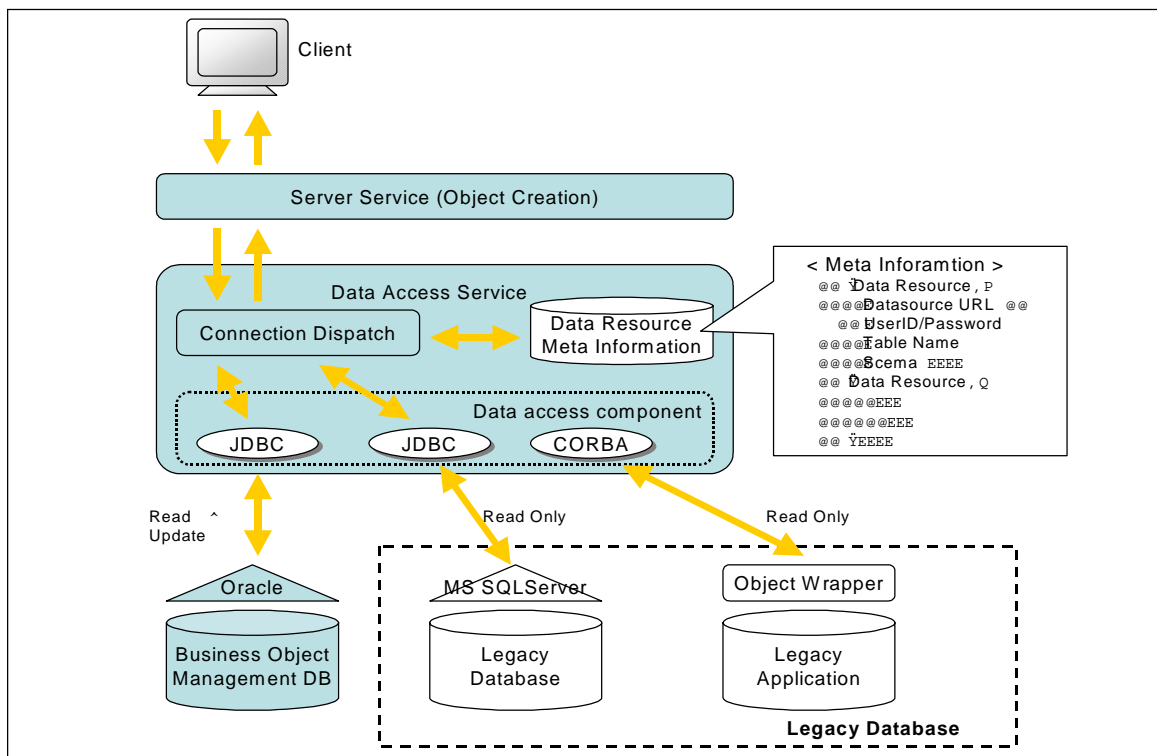


Figure 3: Legacy Database Connection

(4) Security management

In *GIS Platform*, Business Objects, including legacy data, were shared at the corporate level. Flexible security system to manage data-access rights considering organization structure or business usage was provided as following:

- User groups based on usage were defined, and then accessible layer set(s) were assigned to the

group.

- In the layer set assigned to the user group, it was possible to set access rights for each layer (such as view-only, update etc.) Since each layer contained the objects, access rights to both geometry information and property was defined at the same time.
- The security policy was stored separate from the data itself.
- User authentication was done using the existing individual authentication system of Tohoku EPCo, so the user did not need any additional ID/Password for *GIS Platform*.

The benefits of this security system are:

- i) Access control based on various business situations was possible.
- ii) Flexibility in organizational / territory change because of the separation between data and security policy.

(5) Common Digital Map

In *GIS Platform*, after analyzing the requirements for each business unit, it was decided that large scale resident map (1/2500) was suited as a base of digital map.

- *GIS Platform* provided the following data
 - GIS Platform provided 1/2500 detailed map (with house and resident name) for all 80,000 square
 - 1/25000 Medium scale map for overview wide area
- The number of map object (feature) exceeded 100M. This map data was stored in a centralized database at Head Office as well as in the Business Object Management database.
- These map data was accessed through the layer set assigned to the user. The coordinate transformation could be done dynamically if necessary.
- Since the update cycle digital map for each area could be different, meta information about digital map was also accessible to user.

By providing such common digital map data, system introduction / maintenance cost could be significantly reduced.

3.3 Infrastructure for the GIS Platform

Based on the system concept described above, *GIS Platform* was implemented as a centralized common platform using following structure:

- Multi layer architecture was adopted as following.

Client Layer: Tohoku EPCo distributed a Windows-based workstation to each individual. Client layer of *GIS Platform* worked in this environment and provided Common Object Handling Component and application program.

Application Server Layer: The application layer of *GIS Platform* was a collection of Java components running on a server located at the Tohoku EPCo data center. The hardware had a multi-server structure and provided scalability for future expansion.

Database Layer: The database server was also located in the central data center and a high level Unix server was used for reliability. Currently ORACLE is used as sole RDBMS for *GIS Platform*. The sizing of database was done based on future usage analysis. The storage device was an integrated company SAN system and was maintained by total management system.

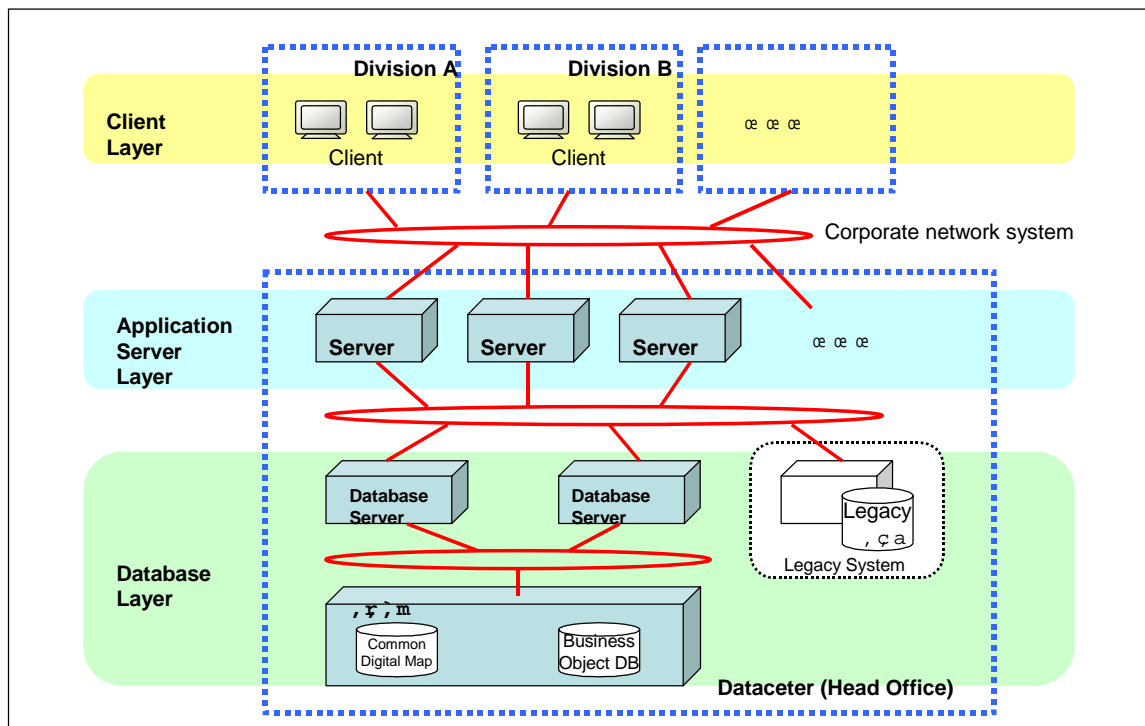


Figure 4: Infrastructure

For the sizing of database, first the model of access frequency and quantity from application programs was created and load tests were done to decide standard for the sizing. In *GIS Platform*, for the efficient use of the system, the response time was regarded as the most important element. To set appropriate sizing standard and to assure enough response, several months of load test were done. Also, when *GIS Platform* was updated to a new version, the same load tests were done to make sure the response was not degraded.

The benefits of the structure of the system are:

- i) Flexibility for the load balancing for busy traffic.
- ii) Scalability for the future expansion.
- iii) Low system maintenance cost by centralized system

4. Important points to realize large enterprise system

The concept and implementation of the *GIS Platform* described in previous sections contains several important points in realizing a large scale GIS system. This section will summarize those points.

(1) To establish system concept first

Before discussing GIS product, it is important to establish a basic system concept based on actual business needs of the company by:

- Analyzing use case of GIS functions in all business activities, then extracting common components to be provided
- Conducting cost/effect analysis, determine actual implementation schedule
Tohoku EPCo took more than one year for this process to have corporate level agreement and to successfully establish a concept of the truly needed system.

(2) Huge GIS Database handling

- There must be consideration given to handling a huge number of spatial objects flawlessly. In *GIS Platform* it was necessary to:
 - Manage all data by a commercial database management system for reliability and usability.
 - Provide a flexible security system to promote usage of spatial object so that physical resource for the spatial data is effectively shared.
 - Provide tools with GUI to promote easy maintenance of the spatial object.
- As base of business system infrastructure, it is necessary to provide good response time.
 - Scalable and flexible system design to keep response time for any expansion
 - Not pursue "state of the art" technology such as J2EE, if there is risk to degrade response time
 - Enforce load test based on actual use case scenario to establish standard for the sizing.
- Consideration for easiness of system construction and maintaining technical skill.
 - Provide solid set of common component to promote efficient business application development. Practically it is important to set development schedule of Component set based on priority.
 - Provide Legacy Database Connection to reuse existing resource (data and application).
 - Use open and standard development environment for easy maintenance. (Java2 environment).
- Consideration on operation:
 - It is necessary to set same level of operation standard as corporate database.
 - Use centralized approach (to have all server/data at Head Office data center) for efficient system management / surveillance

(3) Technology

- Use Open technology for future change
 - •ava™ and OpenGIS™ standard
 - GIS Engine based on multi network layer structure
- Needs reliable vendor for the long term support.

5. GIS Platform status

(1) Development Status

GIS Platform development started in April 2001 and proceeded as follows:

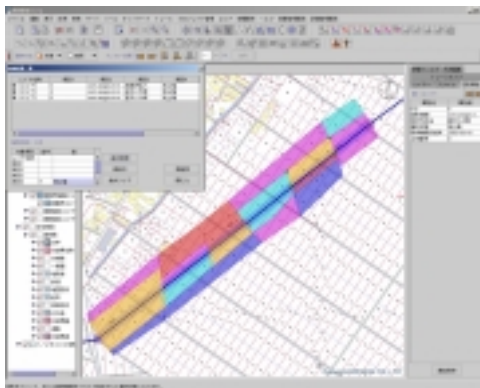
- 2002 April, Common Component and Partial digital map data were available to all users

- 2002 September, Whole digital map was available to all users
- 2003 April, Business Object (Distribution facility) was available to all user

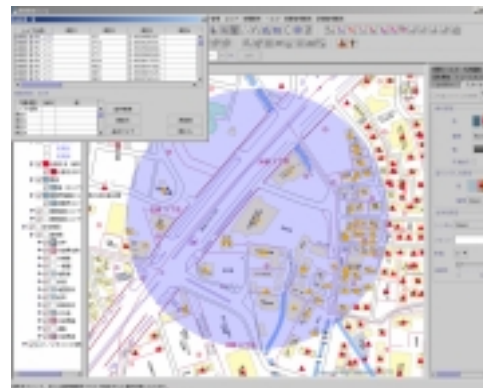
(2) Business application

GIS Platform was applied to actual business tasks starting in August 2002, starting at Call Center Group then Information & Communication System Group, and Land Affair Department, with approximately one thousand clients.

Also, a general-purpose light GIS application was developed and is in the evaluation process now. The target of this project is to create an environment for all employees (12,000 clients) to easily access GIS information. It is scheduled to start in April 2004.



Facility design



Sales analysis

Figure 5: Sample screen of application on *GIS Platform*

●●Conclusion

Tohoku EPCo successfully implemented the enterprise GIS system as described here. We believe it is quite unique to actually construct huge system like this and already be in operation at this point. It continues to be the goal of Tohoku EPCo to promote the usage of GIS data for various business purposes and keep on enhancing the system with feedback from each business unit. For common digital map, other than regular update of the maps, some of new data such as customer location information is planned to add as a part of digital map database.

In Japan, the revision of law in 1999 to promote deregulation caused the electric power industry to become more and more competitive. In that situation, *GIS Platform* is an important information infrastructure to overcome the competition, and is expected to continually to evolve. One example of the future direction considered is to establish the methodology to communicate with outside systems (such as dealing with standard I/F such as MultiSpeak).

<Reference>

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- National Rural Electric Cooperative Association, MultiSpeak Version 2.0, January 2003
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- Sun Microsystems, Inc., Java 2 Platform, Enterprise Edition Overview, 1995-2003