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GEOGRAPHIC INFORMATION TECHNOLOGY (GIT), THE PRIMARY SUCCESS FACTOR IN RESTRUCTURING GAS EMERGENCY MAINTENANCE OPERATIONS

Main author

S. Arai

Co-author

Y. Zaitsu
H. Adachi

Tokyo Gas Co., LTD.

JAPAN

ABSTRACT

Tokyo Gas successfully restructured its gas emergency maintenance operations without degradation of safety level in August of 2005.

Competition in energy markets has escalated in Japan due to deregulation. Consequently, Tokyo Gas must reduce costs while maintaining safety for 50,000 km of gas pipelines and 9.6 million customers.

Gas leakage emergency work is critical for maintaining customer safety. Every year we receive 140,000 calls about gas leakages and follow up by repairing those gas facilities. Originally, we had divided areas of gas distribution into six separate areas and gave responsibility of command for this work to each of the individual areas. However, this setup had the disadvantage of preventing us from allocating field workers efficiently over the total service area.

Consequently, it was decided to restructure the setup for gas leakage emergency work. The plan was to integrate the reception and command centers instead of having them handle individual areas separately. However, this setup had the disadvantage that communications between commanders and field workers become more sparse. To resolve the problem, we developed a support system.

Using this system, we can allocate field workers and cars efficiently, and instruct them to help each other throughout the service area.

The new system makes effective use of the GIT(Geographic Information Technology) related system that Tokyo Gas has developed and operated over many years, which is the main factor behind the success of this restructuring.

This paper introduces the following examples of cases where GIT has been useful:

- Monitoring up-to-date car and field worker positions by using GPS(Global Positioning System)
- Geographic time series analysis of trouble spots
- Sharing of the latest information between commanders and field workers
- Reducing the work required for making reports by using web services

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PAPER

1. INTRODUCTION

In Japan, competition in energy markets has been intensifying due to deregulation. Japan gas prices are said to be currently about double those of other countries, and Tokyo gas has to make the best effort to close this gap. At the same time as cutting costs, we have to maintain the safety of 50,000 km of gas pipelines and 9.6 million customers in Tokyo and its environs.

Gas leakage emergency work is critical for maintaining customer safety. Every year we receive 140,000 calls about gas leakages and follow up by repairing those gas facilities. Originally, we had divided areas of gas distribution into six separate areas and delegated responsibility of command for this work to the individual areas. However, this setup had the disadvantage of preventing us from allocating workers efficiently over the total area and resulted in a high cost structure for this work.

In order to resolve this problem, we have restructured our business processes and developed a new support system for maintaining safety and lowering costs. In this paper, we introduced new GIT (Geographic Information Technology) methods making the best use of know how that the company has accumulated for GIT systems.

2. GAS LEAKAGE EMERGENCY WORK PROCESS RESTRUCTURING

- **Gas leakage emergency work**

Workers involved in gas leakage emergency work are assigned to 3 roles, those of receptionists, commanders, and field workers. Gas leakage emergency operations proceed in the following way.

When a receptionist receives a call from a customer, he or she inputs gas leakage data such as the customer’s name, address, telephone number, and the status of the gas leakage. After that, a commander takes over the work from a receptionist, selects the most effective car and field worker for the work, and dispatches them to the customer’s location.

In order to stop the gas leak promptly, we have to execute this process quickly and efficiently. We must continue to operate this system for 24 hours a day, 365 days a year.

- **Details of the restructuring**

Worker location is a very significant element in restructuring gas leakage emergency work. As shown in Fig.1 (Former location), Tokyo Gas had divided areas of gas distribution into six areas, with responsibility of reception and command handled separately at the area level. However, with this approach, we were not able to achieve the most efficient worker allocation. Therefore we have suggested a new location model. With the new location model, all the receptionists and commanders are brought together at a single location in the center. Field workers remain at the same bases as before.

With the new location, receptionists and commanders can help each other to cover the whole area. Field workers can also help each other regardless of the former area boundaries. Consequently we can allocate workers more efficiently with the new integrated location model. However, there is one demerit in that commanders cannot dispatch field workers as smoothly because they are not the same location, making it more difficult to communicate with each other than it was with the former location model.

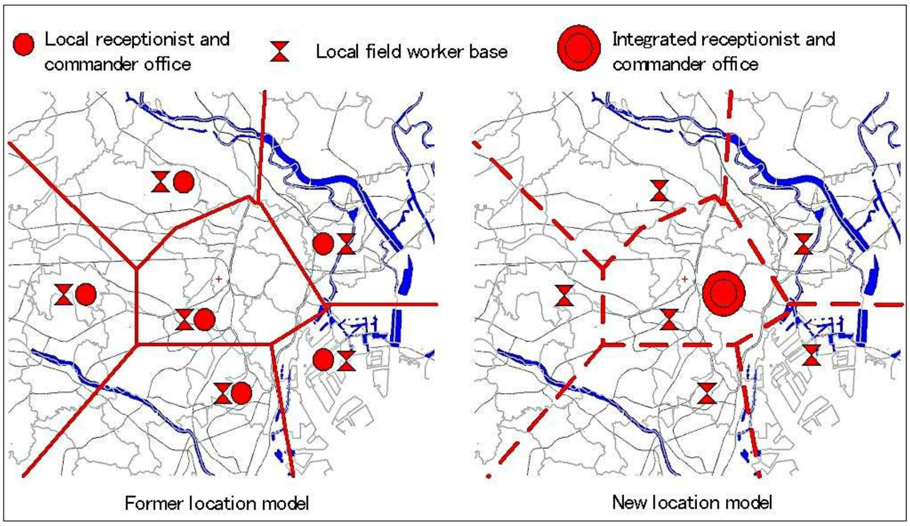

Fig1. Model of location

3. GEOGRAPHIC INFORMATION TECHNOLOGY (GIT)

We have developed and utilized a GIT system called “TUMSY” (Total Utility Mapping SYstem). The development of TUMSY started with analysis of the gas pipeline network in the 1970s. Since then, we are have been making effective use of TUMSY for gas equipment control and in area marketing, etc. It is now an important tool that is indispensable for managing the gas business.

Both the TUMSY engine and the database composition it uses were developed in-house at Tokyo Gas. We are now concentrating on development that creates additional value by uniting existing technology and web services, applications that can be used with cellular phone and the rich clients that have become available based on http protocol communication in the last few years.

GIT systems are widely used in administration and in infrastructure operations as part of natural disaster measures. Recently, the GIT community has recognized that combining GIT systems with a time axis is effective in crisis management for disaster prevention etc. The reason is that it is the first actions that are most important in minimizing damage.

It is similar to gas leakage emergency work, so we planned a GIT-based system incorporating a time concept when restructuring our work.

4. PURPOSE

The purpose of this project is to successfully restructure gas leakage emergency work using the latest GIT functions.

5. SYSTEM COMPOSITION

Fig.2 shows the hardware composition of the entire system. The new system has three types of site. They are the integrated reception and command center, the local field worker bases and the field workers' cars.

Details of individual parts of the system are as follows:

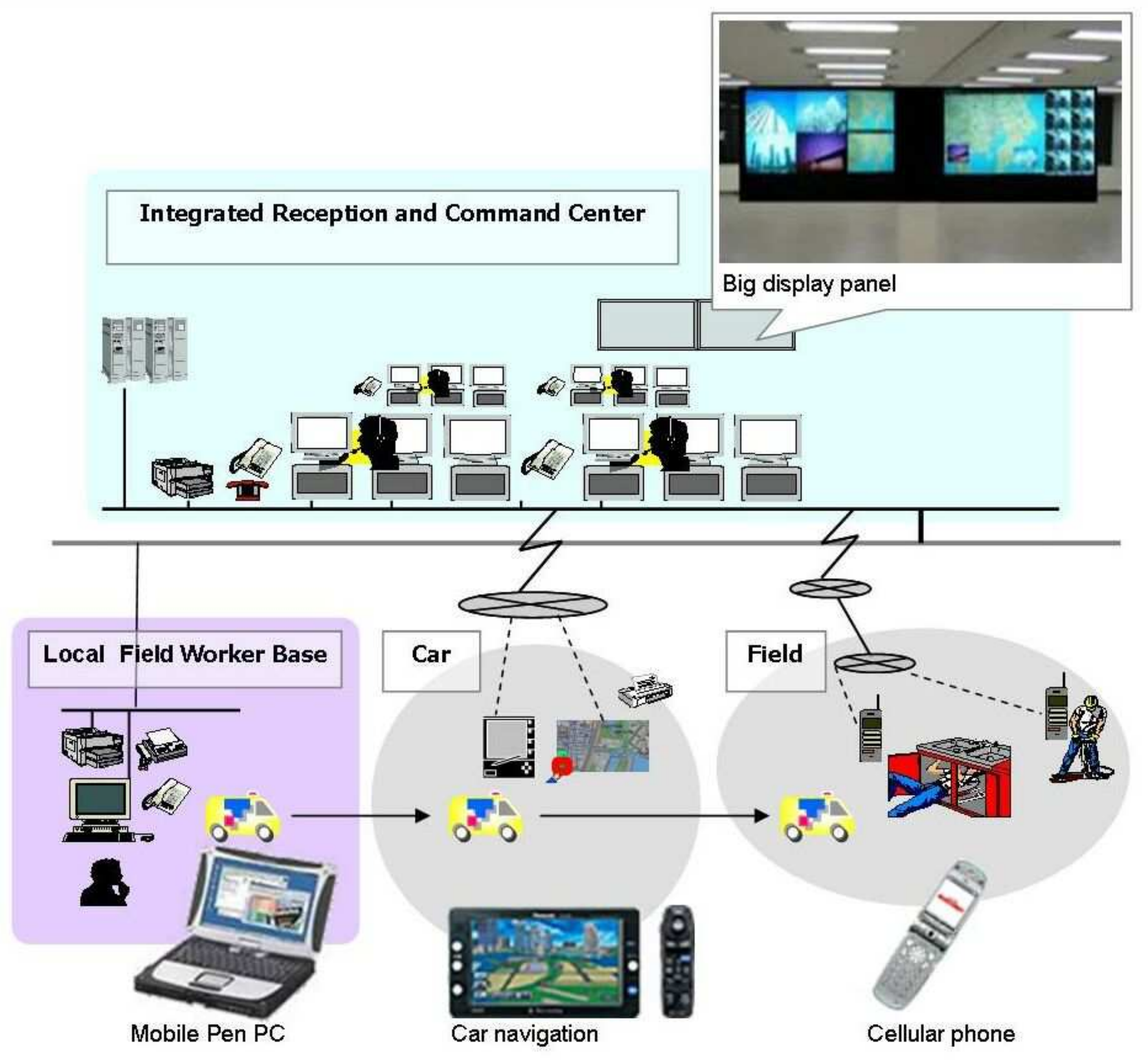

Fig. 2 Hardware composition—Entire system

- **Hardware for receptionists and commanders**

The main hardware at the integrated reception and command center consists of several servers and 50 client PC sets. Receptionists and commanders can show gas pipeline mapping data on each client display. We have also set up a big display panel (50 inches, 12 screens) as shown in Fig.2. We can show a wide area map on the panel.

Though it is redundant, the servers are set up in several separate places and mirrored in order to prevent the service stopping if the hardware breaks down or if there is a disaster. The network is also doubled up by using both wireless and cable.

- **Hardware for local field worker bases, cars and field hardware for field workers**

The same PC sets as used by the receptionists and commanders have been installed at the local field worker bases for the field worker managers. The hardware set in each field worker car consists of a mobile Pen PC, a car navigation system with GPS (Global Positioning System) and a cellular phone with GPS as shown in Fig.2. They are monitored every a few minutes.

- **Software**

Table 1 shows the main software composition of GIS.

Item	**Detailed information**
Operating systems	Windows 2003 Server Standard (Server), Windows XP (Client)
WebServer	Apache,Tomcat,IIS
Database	Oracle 9i Standard, MappingDB(in-house format)
Development language	Java (Server), C++ (Client), VB.NET(WebService)

Table 1 Main software composition

The features of our latest GIS are that it doesn’t depend on the server operating system, that it doesn't influence other client application programs and that it can be operated with low-grade network and computer platforms.

This system requires fast response because of the critical work. Therefore, we developed the mapping cache data and its effective updating mechanism in order to display the map quickly.

6. GIT FUNCTIONS

We incorporated GIT methods for each phase in emergency maintenance operations in order to maximize the advantage of integration, and to minimize the disadvantages.

Details of individual utilized are as follows :

- **From local optimization to total optimization of allocation**

When dispatching workers, the command workers have to identify the leakage and vehicles in order to optimize call-outs. The command center has a large screen displaying the area map. We plot the positions of the leak spots and the progress of gas leak repairs from field workers on the map in real-time. In addition, we can monitor up-to-date car and field worker position on the map using the GPS functions of the car navigation system and cellular phone. Of course, the same information is also displayed on individual displays.

This system makes it easier to visually identify the two-dimensional relationship between leakage spots and vehicle positions, which previously had to be visualized in the mind of the commander. It is very effective for the commander, because the number of field workers to whom instructions can be issued at a time has increased to 20 or 30 per commander because of this integration. It is easy to determine how long the field worker has to travel or how long it will take for the field worker to arrive at the spot.

Commanders can think about the cars and the leakage without having to worry about area boundaries. Therefore, vehicle allocation can be handled by dispatching the nearest available vehicle regardless of area boundaries (Fig. 3). This is one of the most effective advantages of integration. We can also move cars from one site to another without them having to return to base (Fig. 3).

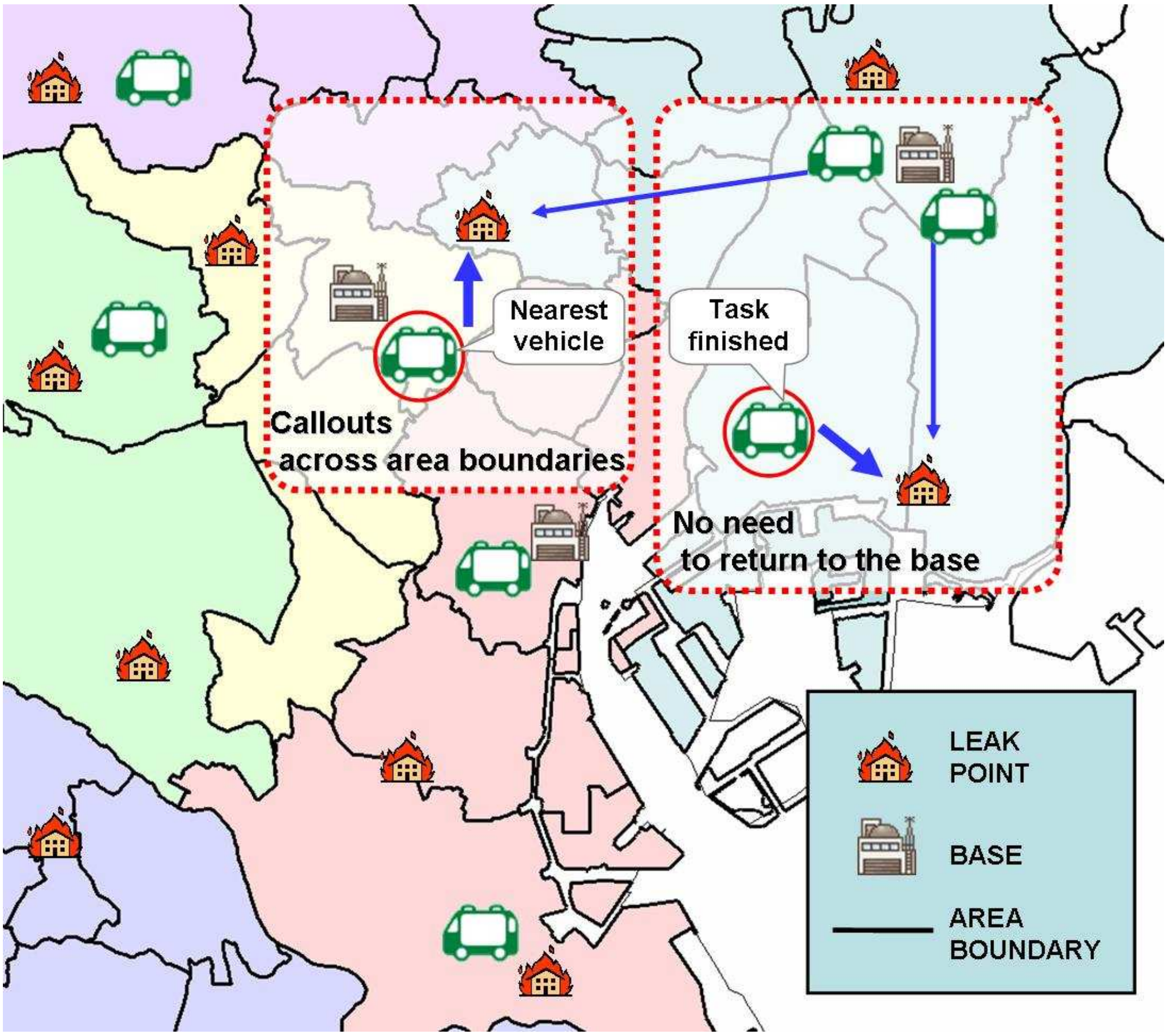

Fig3. Optimize dispatch

Moreover, greater efficiency is achieved because important information, such as large-scale accidents, become easier to identify by watching the display.

- **Geographic time series analysis of trouble spots**

When a large-scale accident occurs, such as huge earthquake and typhoon, we may receive anywhere from several hundred to several thousand calls.

In such cases, it is very difficult to handle all the calls in the usual manner one case at a time. In circumstances like these, the optimum number of field workers need to be mobilized effectively and quickly. This means that we have to analyze how the troubles are expanding to efficiently identify the source of troubles. We have therefore created a useful and appropriate function to analyze the numerous “calls of supply trouble” geographically according to the time of the calls (Fig.4). Using this information we can determine the number of personnel and where to go first.

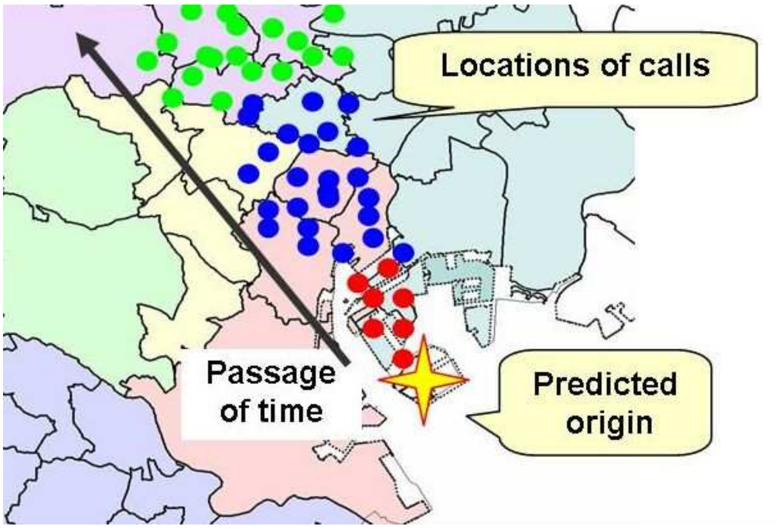

Fig 4. Analysis of call locations

- **Distance of command workers to field workers close to zero**

We distributed 350 sets of notebook PC, car navigation system, and cellular phone to field worker sites. Call-out commands are delivered to the cellular phones instantly. The coordinates of a leak spot are automatically identified using car navigation system, which supports rapid response to the site. Before introducing the system, Commanders were very busy with sending up-to-date drawings to field workers by fax. Now field workers can get these information from the mapping system on notebook PC without commanders' help. This reduces the workload of the commander, enabling commanders to concentrate on their main task of managing field workers.

In addition, when a serious accident occurs, it is indispensable for the field worker to cooperate with the commander to decide the best way of proceeding. In these cases, they can handle the situation more smoothly because they communicate on the basis of sharing the same information. The use of this equipment effectively reduces the distance between the site and the command center.

The system assumes that the notebook PCs will be used outdoors, and thorough consideration has been given to the security. For example, the data stored in the terminal is encrypted.

We also optimized operation, and introduced mechanisms enabling software to be automatically upgraded. This approach has resulted in keeping down the maintenance costs for the field workers' systems.

- **Reducing the work required for making reports**

Reports of repair work must be filed after a maintenance job. A document with a location map is often used in these reports. Before, we had to print a map using a mapping system, and then paste it into the document. Now, the pasting of the location map derived from the address of the repair work has been automated using a web service achieved by combined our existing mapping system with web service architecture (Fig. 5). This reduces the time required for creating documents.

This sort of technology has attracted a great deal of attention because it is easy to use, and utilization is increasing rapidly in Japan.

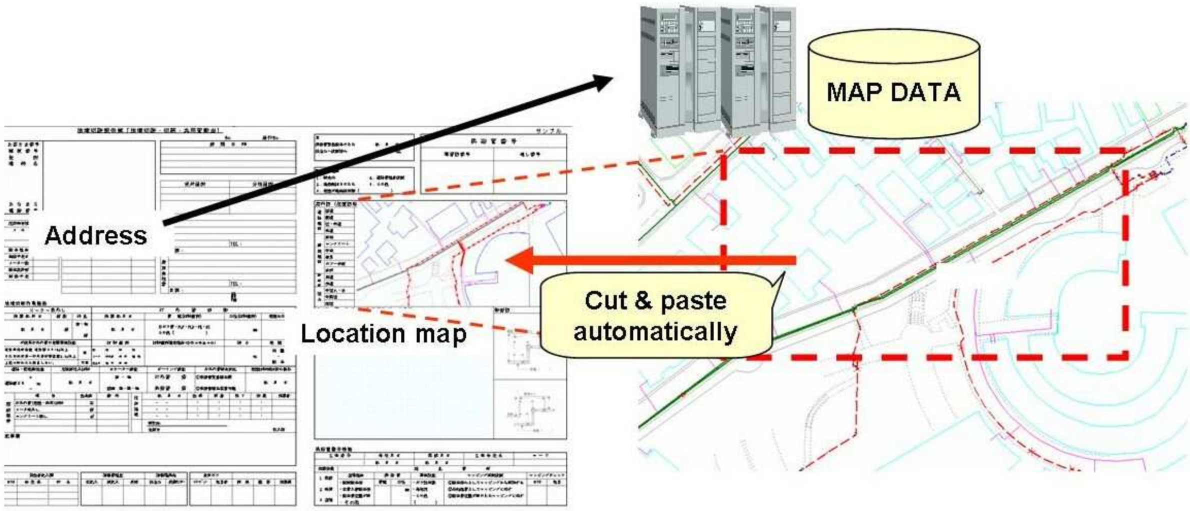

Fig5. Pasting of location map

7. EFFECTS

- **Quantitative effects**

We integrated the command centers, reducing number of command workers. The reduction in labor costs achieved with the command center integration is expected to be at least 12 million dollars over 6 years, which far exceeds the amount of investment.

- **Qualitative effects**

The qualitative effects of introducing this system are as follows :

- ✓ Customer satisfaction improves because receptionists can tell customer arrival time more accurately due to a proper grasp of the real-time location of the car.
- ✓ We can now handle large-scale leakages effectively.
- ✓ Commanders can control gas leakage work efficiently by using up-to-date car and leakage point positions.
- ✓ Commanders can handle more leakages at the same time than before.
- ✓ The time that commanders spend on information gathering has been reduced.
- ✓ Field work quality improves because field workers can refer to a range of information, and the workload is more uniform as workers help each other over the whole area.
- ✓ The time that field workers spend in making reports has been shortened.

8. CONCLUSION

We successfully integrated the command centers without degradation of safety level in August of 2005. This system has contributed greatly to the increased efficiency of allocating field workers and cars, and enabled us to restructuring this work.

By using GIT, we succeeded in decreasing the effective distance between command workers and field workers, and in enabling command workers to identify leakages and vehicles over an extensive area in real time. These were most important factors of the integration. GIT is therefore essential for emergency operations.

We are convinced that GIT was an indispensable factor in the successful restructuring of gas leakage emergency operations. Previously, GIT had been widely used in fieldwork to handle the concept of “where”. This time, we have achieved greater efficiency by incorporating the concept of time, such as information acquisition in real-time and time series analysis. We also proposed a new use of

GIT combined with web services. We are also convinced that effective use of GIT, as used in leakage operations, could be applied to other gas operations. This will lead to cost reductions and improvements in quality of work.

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