

## ELECTRICITY FACILITY OPERATION MONITORING SYSTEM USING WEB-GIS

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### ABSTRACT

Monitoring system is useful to optimize distribution facility operation and answer customer inquiries quickly. To do this the system should be easily accessed and work in real time. To increase efficiency and stability of field operation system, KEPCO has upgraded the legacy system and extended it to WEB-GIS based monitoring services. The main functions include outage area display, outage facility detail information display, electric facility construction area display, call-center interface, field dispatching mobile system interface and WEB-GIS map control (map settings, object detail, network trace, plot map, data export, etc). It will help operators monitor facility state and respond to customers immediately. It will also be the core technology of KEPCO's next generation electric facility management system and Smart-Grid.

### INTRODUCTION

Korea Electric Power Corporation (KEPCO) controls all power distribution lines in Korea, KEPCO has divided the country into 14 districts and 190 branches. To integrate and manage power distribution processes centrally, KEPCO developed New Distribution Information System (NDIS) based on GIS (Geographical Information System). NDIS allows of efficient power distribution line management and improves resource accuracy. KEPCO's NDIS provides data on 8,148 distribution lines, 8 million poles and 400 thousand c-km of High Voltage power lines.

At present, all outages occurring in distribution lines are registered in the central KEPCO call-center; the call-center then informs the crew of the outage position and expected outage area and communicates with the facility management department by phone. The whole process takes a long time so there is a need for real-time facility supporting system, and thus KEPCO has developed a new electricity facility monitoring system using WEB-GIS technology. In 2010 this system was recognized as excellent utility management system in GITA(Geospatial Information & Technology Association) conference.

### BUILDING WEB-GIS SYSTEM

A supporting system between the call-center, branch and head office needs to be constructed to provide distribution facility information from the GIS database in real time.

The new WEB-GIS services are based on Internet Application Server Technology. It uses the GIS DB to display an electricity facility map. The main functions include outage area display, outage facility detail information display, electric facility construction area display, call-center interface, field dispatching mobile system interface and WEB-GIS map control (map settings, object detail, network trace, plot map, data export, etc). The WEB-GIS system allows accessibility more easily than typical C/S (Client/Server) GIS systems. WEB-GIS uses up-to-date WEB technology (JAVA, JSP, JS, etc) and additional applications can be built.

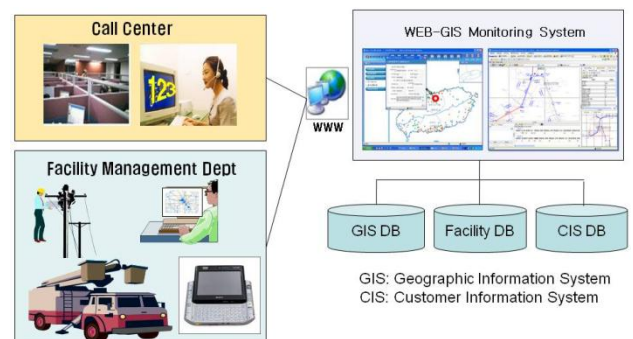


Fig. 1 WEB-GIS System Overview Diagram

### Comparison with Legacy C/S GIS

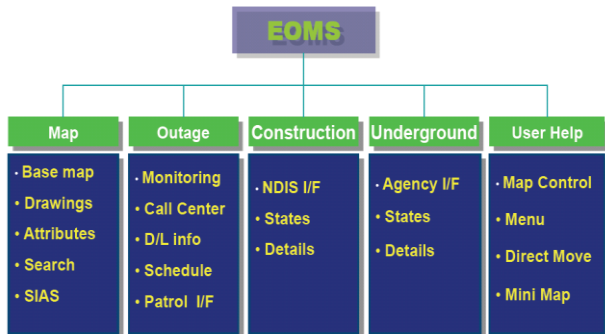
	Legacy C/S GIS	WEB-GIS
System installation and use	Program needs to be installed, takes time at start-up.	Just connect to WEB site using browser
Extensibility and application	Function limit and interface limit	Additional applications possible

### MAJOR FEATURES OF WEB-GIS SYSTEM

The WEB-GIS system's main features are described below.

**Main Menu**

EOMS(Electricity facility Operation Monitoring System) has 5 main menus.



**Main Portal**

Facility operation personnel and call-center staff in all districts of KEPCO service can connect to EOMS via main portal windows display.

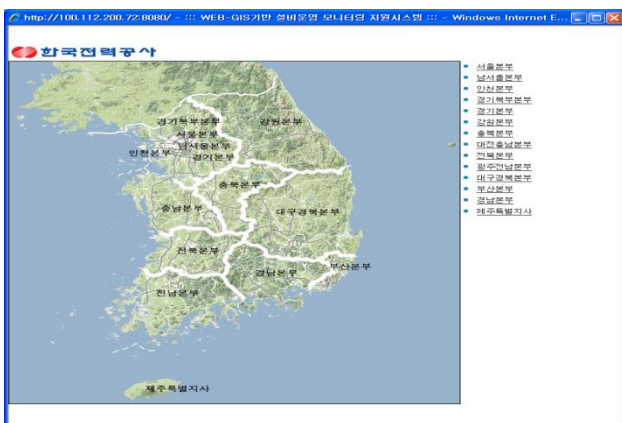


Fig. 2 Main Portal Window of WEB-GIS

**Main Functions**

**Outage Management Monitoring**

The outage area is displayed on the WEB-GIS map, displaying the position of outage which is reported in call-center a day using real-time outage calls from customers. User can access detailed fault facility data and the system can predict transformer interruption using call-center call analysis. The system provides the location of a patrol mobile system based on GPS and result of works in real time. The facility management department and call-center staff can use the system to quickly deal with interruptions. And the system provides breaking news about day outage, outage customer/area condition(outage time, status, repair time), outage customers detail(category, outage sensibility, contact telephone number, power supply contract etc..), outage section information, customer and district information on distribution-line classification. Also it provides scheduled outage plan for line repair or new

customer power supply within specific period of time



Fig. 3 Outage Monitoring Screen [displaying the position of outage in different color depending on the state of outage]

**Patrol Mobile System Interface**

When an outage call is received, a system patrol car is dispatched to the customer. A mobile system is installed in the patrol car, the system has GPS, navigation function, command receiver, work order management function etc. The patrol car crew can receive commands from a distribution center and the call-center in real time via wireless communication, as well as register the results of outage recovery.



Fig. 4 Patrol Mobile System [displaying the outage point and route using GPS via wire-less communication network]

**Facility Construction Monitoring**

The system provides electricity facility construction stages – starting work, re-starting work and suspension work stage. The stage information is linked with the NDIS distribution facility design system so supervisors and personnel can monitor construction area, overview, stage etc.. on the WEB-GIS map. In KEPCO electricity engineers design distribution plan and detail power supply plan for repairing and new customer on GIS map.

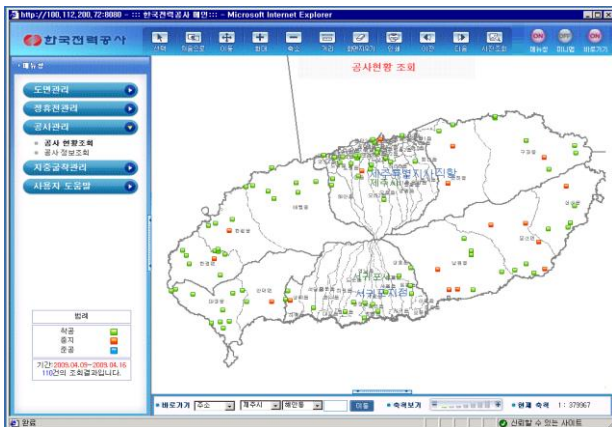


Fig. 5 Facility Construction Monitoring Screen

**Underground Facility Excavation Monitoring**

KEPCO expects that the number of outages caused from underground excavation will increase annually, so we have built a WEB-GIS system which communicates with the government agency system to share excavation information.

Underground facility excavation information is displayed on the WEB-IS map to assist the facility management department during excavation work to prevent facility breakdowns. The system communicates with the local government's system via VPN (Virtual Private Network). It automatically displays excavation information on screen in real-time.

It will be helpful to decrease underground facility faults and to manage field work.



Fig.6 Underground Facility View Screen

**Map Control and Facility Statistics**

The system provides basic GIS functions (electricity facility search, map control, facility picture inquiry, facility detail specification inquiry, etc). Facility data can be exported to Microsoft Office software(like Excel, MS-doc etc). And there are many useful functions.

(Electric network trace, geographical facility query, trails, Print, plot, bookmarks, style control, projection change).

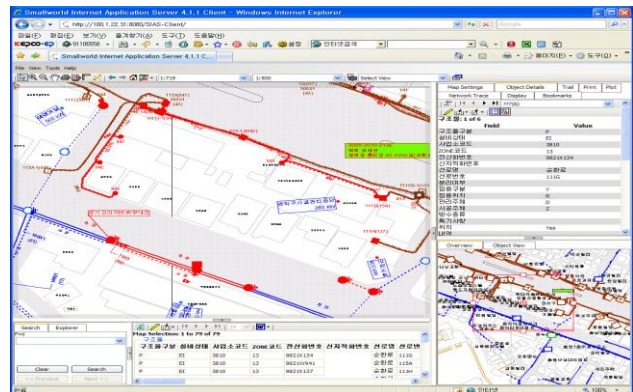


Fig.7 Electric Facility Statistics Screen

**APPLIED TECHNOLOGY FOR WEB-GIS**

SIAS (Smallworld Internet Application Server) is a special server which makes direct access to spatial information or application program possible within internet using standard web protocol.

**Web Service Architecture**

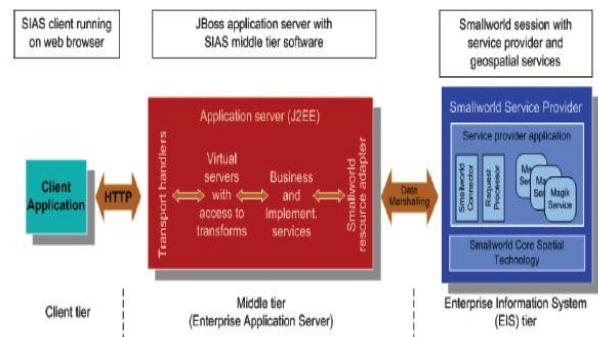


Fig. 8 Overview of SIAS architecture

SIAS system consists of three tiers - Client tier, middle tier and EIS(Enterprise Information System) tier. The client tier means client application which is hosted by a web browser. The SIAS Client utilizes JSF (Java Server Faces) technology. JSF is server side technology which is fast, extendable and supports dynamic web pages. The middle tier is comprised by J2EE application server. SIAS 4.1 supports the latest release of JBoss application server program, and will support other application server in next release as well. J2EE is an application server platform leading WEB. It provides standard mechanisms about session, state information, security and failover. The EIS tier is a Smallworld session which includes a service provider application and spatial information.

## System Architecture

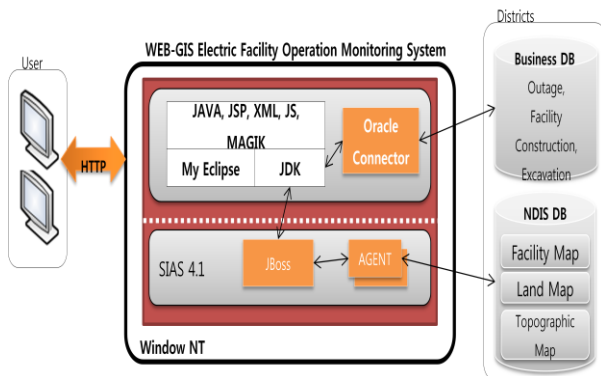


Fig. 9 WEB-GIS System architecture

WEB-GIS is a web environment system based on SIAS 4.1 so that the GIS map is easily available through a web browser. JBoss which is placed in SIAS is used as a WAS (Web Application Server). And several agent program delivery map requests from users to system and delivery results (facility map, topographic map, land base map etc.) to users back.

## IMPLICATION AND FUTURE TASKS

There are many benefits from WEB-GIS but we need to improve some functions for more utilization and effectiveness.

- Need to improve performance and response time
- Need to develop various application functions on GIS map control and user interface
- Display form according to scaling in facility map
- Need to develop a method of GIS integration for distribution and transmission
- Need to develop facility input function added to existing inquiry function (distribution facility design, edit, delete etc.)

KEPCO is now considering how to extend the system's real-time interface by incorporating DAS (Distribution Automation System) and satellite maps. This will be the infra technology of KEPCO's Next generation facility management system and Smart-Grid. Now KEPCO is building test bed for Smart-Grid field test in Jeju-island from 2009 to 2013. Main areas of test bed are Smart Power Grid, Smart Place (two-way information exchange between customers and suppliers), Smart Transport (EVs), Smart Renewable (wind, PVs), Smart Electricity Service. WEB-GIS monitoring system will be the base system for operation of Smart-Grid and integration with other systems (SCADA, OMS, DMS, Field Mobile, Distribution Information System, Customer Information System, AMR etc.)



Fig. 10 Smart-Grid Monitoring View

## CONCLUSION

There are some restrictions to monitor work in real-time with Client-Server based GIS which is used in KEPCO's NDIS. First of all, only people who have installed GIS client in their computer can use GIS system because of license issue. Secondly, program loading time is long which is the characteristic of a client program. This is inconvenient for users to do monitoring work. Finally it is difficult to be interface with other Web systems. With WEB-GIS System it is possible to monitor the facility in real-time. That helps operators serve customers promptly and optimize facility operation. Most of all, it is important to secure preliminary technology of GIS for developing KEPCO's next generation distribution information system. The primary advantage is that it can be used as basic technology in government-leading Smart-Grid, connecting with DAS (Distribution Automation System) or AMR (Automatic Meter Reading System).

## References

- [1] The Korean Institute of Electrical Engineers "Distribution System Engineering", Bookshill, 2006
- [2] Korea Electric Power Corporation, User Manual, Facility Operation Monitoring System based on WEB-GIS", 2008
- [3] GE-Energy, "Smallworld SIAS 4.1 Administration", 2007