*Transactions of the Korean Nuclear Society Spring Meeting*
*Chuncheon, Korea, May 25-26 2006*

# Case Based Asset Maintenance for the Electric Equipments

Ji-Hyeon Kim, Jae-Cheon Jung, Young-Woo Chang, Hoon-Seon Chang, Jae-Cheol Kim, Hang-Bae Kim,
*Korea Power Engineering Company*
*jhkim10@kopec.co.kr*
Kyu-Ho Kim, Yong Hur, Dong-Chul Lee
*Korea Electric Power Data Network*
*khkim@kdn.com*

## 1. Introduction

The electric equipment maintenance strategies are changing from PM(Preventive Maintenance) or CM(Corrective Maintenances) to CBM(Condition Based Maintenance)[2]. The main benefits of CBM are reduced possibility of service failures of critical equipments and reduced costs or maintenance work. In CBM, the equipment status need to be monitored continuously and a decision should be made whether an equipment need to be repaired or replaced. For the maintenance decision making, the CBR(Case Base Reasoning) system is introduced. The CBR system receives the current equipment status and retrieves the case based historic database to determine any possible equipment failure under current conditions. In retrieving the case based historic data, the suggested DSS(Decision Support System) uses a reasoning engine with an equipment/asset ontology that describes the equipment subsumption relationships.

## 2. Case Based Reasoning

### *2.1.Main System architecture*

Figure 1 shows the overall equipment status monitoring system architecture where the CBR system exists as a subsystem. The dotted circle of DSS includes the CBR subsystem. The Equipment/Asset status is monitored from the field sensors and SCADA(Supervisory Control and Data Acquisition), and sent to the various on-line status monitoring systems and also transmitted to DSS. There are three layers of standard communication lines for each purpose[3]. The bottom layer is for OPC(OLE for Process Control) oriented communication for on line monitoring, MIMOSA OSI/EAI(Open System Architecture for Enterprise Application Integration) CRIS(Common Relational Information Schema) database and SCADA. The middle layer is for MIMOSA OSI/EAI oriented data communications for high level monitoring system, EAM(Equipment Asset Maintenance), and Work Management and DSS. The highest line is for Web service communication that use the HTTP/SOAP protocols. The Web service servers defines their services in WSDL(Web Service Description Language) for top layer clients. ERP(Enterprise Resource Planning) can be a typical Web service client.

### *2.2.Case Based Reasoning System*

The dotted circle of Figure 1 and its external interfaces are described in Figure 2. CBR follows a cyclic process of retrieval, reuse, revise and retain[1]. Once the DSS receives the current electronic device status, it retrieves historic cases from the database server to check whether there exists the same case as current situation for any possible conditions that require maintenance attention.

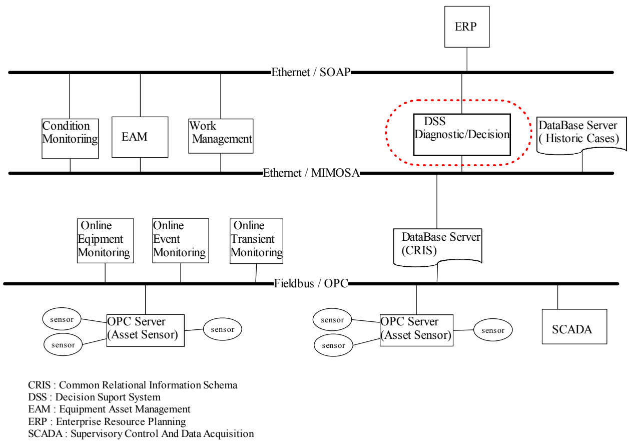


**Figure 1. Equipment/Asset Maintenance Main System Architecture**

If a case is found, the DSS returns the found case for maintenance attention. If a case is not found, the DSS retrieves the case database one more time with the CBR system. CBR supports the reasoning of equipment subsumption relationships. In Description Logic, subsumption is typically written as $C \subseteq D$ which means the concept denoted by *D* (the *subsumer*) is considered more general than the one denoted by *C* (the *subsumee*)[5].

The CBR solving paradigm can support intensive scrutinizing of the possible equipment failure.

For example, GIS, one of a substation equipment, includes GCBs and DSs. The subsumption relation between GIS and GCB can be expressed as $GCB \subseteq GIS$. When DSS wants to find a case related to GCB failure and the information is not registered in the case database, DSS can try to extract the case information of GIS according to the subsumption relationship. The found information may not be exactly true but can be a

possible candidate describing the current equipment status. For more accurate equipment diagnostics, CBR result can be used with other tools like Bayesian Belief Networks which adopts reliability calculations[4].
The found case is reused and revised to customize current condition, and added to the historic case database(retain) for future uses. The new case that does not exist in case database also should be entered in the historic case database.

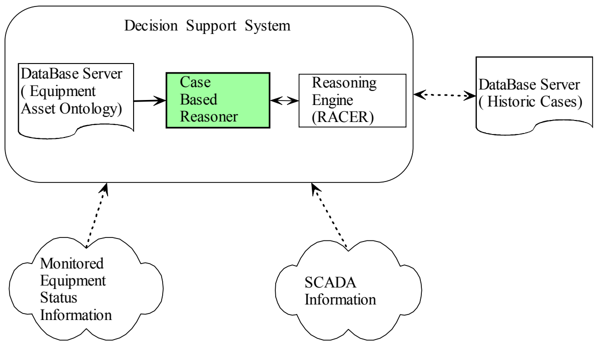


**Figure 2. Decision Support System Overview**

*2.3.Equipment Ontology*

A reasoning engine should have rules and instances for reasoning process. These rules and instances are defined in an equipment Ontology. The Ontology defines the equipment parent/child and aggregation relations. The DSS system performance is greatly dependent on the design of the Ontology.

## 3. Conclusion

A CBR based decision support system is introduced for condition based equipment maintenance. The main purpose of applying CBR is to predict possible equipment failures with accuracy. Merely applying the case based historic data has limitation of finding only the same condition of current monitored status. Using the CBR system, the possible retrieved domain from the historic case database is enlarged by applying the reasoning with defined Ontology of equipment relations. In current design, the Ontology includes only simple equipment relations but can be extended to include complex rules that define conditions-results for equipment status for more sophisticated DSS system.

## REFERENCES

[1] Mohamed A.K. Sadiq, Case-Based Reasoning with knowledge Hierarchies and XML, E-Commerce: Theory and Practice, 2002
[2] Kevan Slater Schematic Approach Inc., Data Integration “The Next Step”, IMC-2005
[3] Mark Mitchell, Steve Quillen, Forrest Pardue and Dick Hancock, COMMUNICATION and ACCOUNTABILITY are the KEY to SUCCESS in CONDITION-BASED MAINTENANCE, IMC-2005
[4] KOPEC, Development of the Intelligent Predictive Maintenance Methodology and Tools for NPP, pp.9-10, October, 2002
[5] Franz Baader, Diego Calvanese, Deborah McGuinness, Da niele Nardi, Peter Patel-Schneider, the Description Logic Han dbook, Theory, Implementation and Applications, Published J anuary 2003