An Advanced Diagnostic Display for Core Protection Calculator System

Ji-Hyeon Kim, See-Chae Jeong, Se-Do Sohn
Korea Power Engineering Company (KOPEC)
jhkim10@kopec.co.kr

1. Introduction

The main purpose of a Nuclear Power Plant Instrumentation and Control (I&C) Display System is to provide operator's interface for I&C systems.

The CPCS display(Shin-Kori 1&2) provides operators with 1) plant monitoring values of field input and algorithm variables that reflect the reactor core conditions, 2) operation values that operators can change and 3) CPCS status. It will be an optimal case if operators can understand the plant (including CPCS itself) condition intuitively with the displayed values but it is not easy in CPCS. For example, if the CPCS Channel Trouble light is lit, operators need some amount of time to investigate what caused the trouble light because there are more than hundred causes that can generate the channel trouble.

If a Display supports diagnostic information that shows what cause the displayed alarms, it will greatly help operators in easy understanding the CPCS status. To provide these diagnostic information, this paper suggests an active self-explanatory display mechanism. This self-explanatory diagnostic display mechanism utilizes an ontology[3] in XML[1] that describes parent-child, sibling relationships of display variables, through which in-depth, in-breadth diagnostic tracking is possible.

This paper consists of two parts. First, the key features of CPCS Flat Panel Display System (FPDS) are described. Second, the features of active self-explanatory diagnostic display are discussed.

2. Current CPCS FPDS Features

The CPCS FPDS uses the QNX Photon microGUI products as the Man-Machine Interface system. The FPDS software program includes independent processes that use values from the AF100 bus, safety networks, to dynamically drive the objects on the FPD, and for the FPD to send data over the AF100.

Among the FPD displays, the plant monitoring and operations displays are plant specific and excluded in the discussion. The other FPD displays, i.e., system status display, are oriented to I&C system point of view and includes on-line diagnostics for use in safety system. Fig.1 shows the CPCS FPD System Status functions overview. The independent processes represented in ellipses perform data communications, system integrity check, system event listing, device I/O function for processes status reporting.

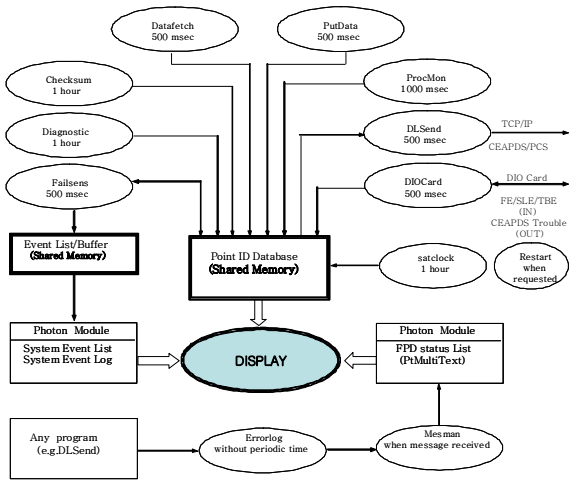

Figure 1. FPD System Status Function Overview

For FPD interfaces with external system, there are processes Datafetch, DLSend, DIOCard and Satclock. The Datafetch supports online AF100 interface and at every transceiving point, the data are strictly controlled under checksum integrity check. The DLSend broadcasts data from FPD to external systems of Plant Computer/Control Element Assembly Position Display through TCP/IP and the DIOCard reads Digital input and set the values of Point Identification(PID) Database. Satclock sets the system time from a satellite clock source through AF100 time synchronization protocol.

For the FPD on-line diagnostics, there are Failsens, Errorlog, Mesman, Checksum, Diagnostics, ProcMon and Putdata. These processes maintain the linked list of system event entries, capture error outputs from other processes and send them to FPD status list, calculate checksums for the FPD code segments and shared memory, check the existence of processes, and maintain the FPD heartbeat counts to make sure of FPD alive.

3. Self-Explanatory CPCS FPDS

The overview of suggested active display system that supports diagnostic display is described in Fig.2. To support the diagnostic, an ontology in Extensible Markup Language (XML) is used(Table 1). XML is an application of Standard Generalized Markup Language and has good advantages in storing data. The ontology keeps the information of parent-child, sibling relationships between each displayed values.

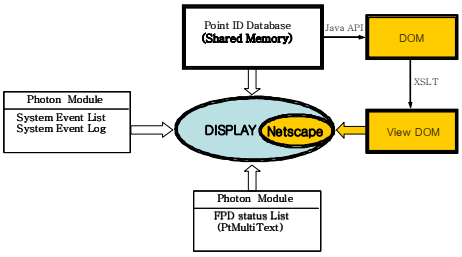

Figure 2. Active Display System Overview

The ontology is parsed into a mother-body Document Object Model(DOM) and the CPCS system values in this DOM is periodically updated from PID Database through Java Application Program Interface. An on-line Extensible Stylesheet Language Transformations (XSLT)[2] program that generates new view DOM is used to support user friendly dynamic view according to the system values in the DOM. The contents of this newly generated view DOM are displayed through common Web browsers.

```
<?XML version="1.0" ?>
<!DOCTYPE Diagnostic [
<!ENTITY Description "This is a CPC FPD DN Docs>
<!ELEMENT DNNode (forLink*,bacLink?,CANode)*>
<!ATTLIST DNNode Name (#CDDATA)
            LitOnStatus (on | off) "off"
            LeafNode (yes | no) "no">
……
<!ELEMENT forLink ANY> // Same pattern for bacLink
<!ATTLIST EXTENDED
  XML-LINK  CDDATA  #FIXED "EXTENDED"
  ROLE      CDDATA  #IMPLIED
  …..>
<!ELEMENT LOCATOR ANY
<!ATTLIST LOCATOR
  XML-LINK  CDDATA  #FIXED "LOCATOR"
  ROLE      CDDATA  #IMPLIED
  ….. ]>
<DNNode Name="CHANNEL TROUBLE"> // 1st level
<forLink INLINE="FALSE">
<LOCATOR TITLE= "OM/MTP Error Flag"
  HREF="#ERTRPFPD"/>
<LOCATOR TITLE= "FLOW Error Terminal Word"
  HREF="# ERR_TERM_FLOW"/>
 ….
</forLink>
<DNNode Name="OM/MTP Error Flag" > //2nd level
<forLink INLINE="FALSE">
<LOCATOR TITLE= "RDB CRC Error"
  HREF="#ERTRPFPD_0"/>
<LOCATOR TITLE= "OM AddCon DSP error"
  HREF=" #ERTRPFPD_1"/>
  ….
<DNNode Name=" RDB CRC Error" LeafNode="yes"> //3rd level
<bakLink INLINE="FALSE">
<LOCATOR TITLE= "OM/MTP Error Flag"
  HREF="#ERTRPFPD"/>
  …
</DNnode> //for 3rd level
</DNnode> //for 2nd level
</DNnode> //for 1st level
```

Table 1. Diagnostic Ontology XML Schema and Document

The following Table 2 is an example of Active Self-Explanatory diagnostic display that is manifested when operator asks by pushing CHANNEL TROUBLE button in display screen.

CHANNEL TROUBLE
- Alarm Error Terminal (ERR_TERM_CPCALA)
- ***OM/MTP Error Flag (ERTRPFPD)***
  - RDB CRC Error (Bit 0)
  - ***OM AddCon DSP error (Bit1)***
  - ……
  - MTP Trip Bypass DSP error (Bit 11)
- FLOW Error Terminal Word (ERR_TERM_FLOW)
- …….
- CPC I/O Module Error Flags (ERRTRMOD)

Table 2. Diagnostic Display Example

The bold italic character shows the cause of upper level alarms. In this example, the CHANNEL TROUBLE is caused by OM/MTP Error Flag, and the OM/MTP Error Flag is caused by OM AddCon DSP error bit.

4. Conclusion

The key features of nuclear safety system display are explained with an example of CPCS Flat Panel Display System. For operator's convenience, an self-explanatory diagnostic display using XML ontology is introduced. The diagnostic display provides well organized system status overview and in-depth trouble tracking methods. The suggested diagnostic display can be applied to the system function algorithm also even though we introduced the diagnostic example only for system status variables as a beginning point. The suggested display can be applied to safety displays through qualification of XML, Java and Web browser on current QNX platform.

REFERENCES

[1] Extensible Markup Language (XML) 1.0 (Fourth Edition) W3C Recommendation 16 August 2006.
[2] Extensible Stylesheet Language (XSL) Version 1.1, W3C Recommendation 05 December 2006.
[3] Ji-Hyeon Kim et al, Development of an Web Service Architecture for Enterprise Application Integration, Transaction of the Korean Nuclear Society Spring Meeting, May 2007.