

# C&I SYSTEM DIAGNOSTICS WITH SELF MONITORING AND REPORTING TECHNOLOGY (SMART)

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## ABSTRACT

In a Power Station the process stability depends on the healthiness of control & Instrumentation system. The proper diagnosis, monitoring and timely action is utmost important for maximum generation. The major part of process disturbances and outages in C&I system are due to failure of electronic modules, power supplies and field instruments. In majority of the cases the redundancy exists. However, the operator who monitors the process concentrates on process alarms rather than the control system related alarms. Redundancy failure alarm on control desk is neglected many times if there is no process disturbance. So this leads to non-availability of redundancy and after which outage may occur due to equipment failure. The disturbances and redundancy failures are to be monitored and rectified by a control system engineer on a continuous basis to maintain "Zero loss of Generation" due to the control system by design. But in power stations with multiple units and variety of Control systems it is difficult and practically impossible to monitor these discrepancies.

NTPC Ramagundam is a 2600MW power plant situated in Peddapalli district of Telengana, India. The stage-1, 3X200MW units, are commissioned by the year 1984. The Stage-2 ,3X500 MW units, are commissioned by the year 1989. The Stage 3, 1x500MW unit, is commissioned by the year 2004. The control systems different for various stages, from latest to legacy. This paper explains about designing and development of a common dashboard with Self Monitoring And Reporting Technology in NTPC Ramagundam. In this system, any failure in control system will be communicated immediately to the concerned person without any intervention of operator on desk. This paper explains about challenges in bringing up the communication between the variety of control systems (from legacy to latest generation) systems securely to a common dashboard. This paper explains how the Enterprise data server concept can be used in developing the integrated diagnostics system with self monitoring and reporting technology. It also explains different methodologies adopted for integrating old control systems to the dashboard without comprising on the security of the control system.

## Keywords

*Redundancy failure, Enterprise Data Server, SMART, Integrated Dash board, Null disturbance Generation*

## INTRODUCTION

In power plant, the design of control system is having high level of redundancy, from field instruments to the electronic cards and power supplies. Also many modifications were implemented by experience to avoid any spurious trips due to design over the time.

However, we often come across the trip reports like "Unit tripped on Hydrogen cold gas temperature high. One of the three cold gas temperature points was already sensing high due to card fault but was not visible as that point was not available at HMI display. One more point became high due to card failure causing operation of the protection". Sometimes "Unit tripped on card failure. One of the processor was found in alarm and other processor got failed".

The major part of controllable loss of generation on account of C&I are due to failure of Electronic modules, Power supplies, Field instruments, Network & System components where the redundancy exists by design. The main reasons for these types of outages are due to improper monitoring of the redundancy. In case of process measurements, the general control philosophy is to take trip input from 2/3 logic. If any two measurements set out of three it is taken for equipment process abnormal trip. However, if any two measurements fail, it is also taken for

equipment trip considering equipment and process safety. Hence if any one measurement goes bad, there is ever scope for rectification before the other one goes bad. This is only possible with timely monitoring and proper planning. The same is the case with power supplies and network systems connected to control systems.

The operator on the desk, who is responsible for monitoring the alarm, may sometimes neglect upon the redundancy failure alarms as there is no impact on the running process at the time of alarm. Sometimes he may not also understand the meaning of the alarm generated due to advanced Control Systems & networking terminology. Sometimes System limits for providing more number of alarms. Hence there should be some mechanism for prompt messaging of these kinds of alarms for early rectification.

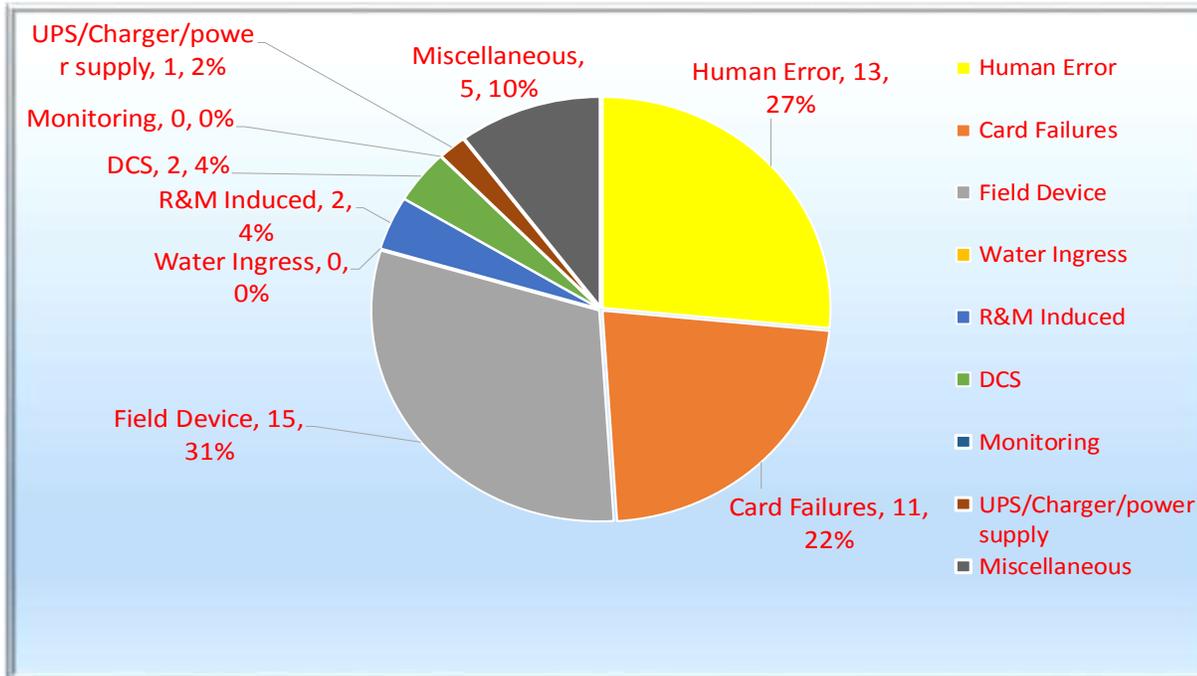


Fig1: Analysis on number of C&I trips in NTPC

Fig1 shows total number of trips due to C&I in different categories across all NTPC plants during the year 16-17. Trips like Card Failures(22%),Field Devices (31%) ,DCS(4%) & Power Supply totally contribute 57% of total trips. These trips can be totally eliminated with the help of SMART . This analysis includes only number of unit outages, but there will be many more instances which cause partial generation loss.

This paper explains the development of a common dash board featuring SYSTEM DIAGNOSTICS WITH SELF MONITORING AND REPORTING TECHNOLOGY developed in NTPC Ramagundam.

### DATA ACQUISITION

The main challenge is to interface various variety of existing control systems to a single point without compromising control network security.

The control system in NTPC Ramagundam Stage-1(3X200 MW) consists of turbine of M/s Ansaldo with EHC control system of Elsig (Electronics San Gorgio) and HP LP bypass & PRDS consisting of Sulzer make AV5 system. DAS system before R&M was of ABB make. Steam generator was Babcock & Wilcox design, with SIE Forney based SP-47 control system. After R&M all systems were integrated into one system of Emerson make Ovation except turbine integral & HP LP Bypass system. The stage2 (3x500MW), TG control system was BHEL make EAST (Iskmatic based) Control system, FSSS was Gould Modicon PLC based system, ACS was Siemens Teleperam M and DAS system was of Cegelec make. After recent R&M all the controls of Stage-2 are under single DDCMIS of Honeywell. The stage3 (1x500MW) is having BHEL make maxDNA DCS.

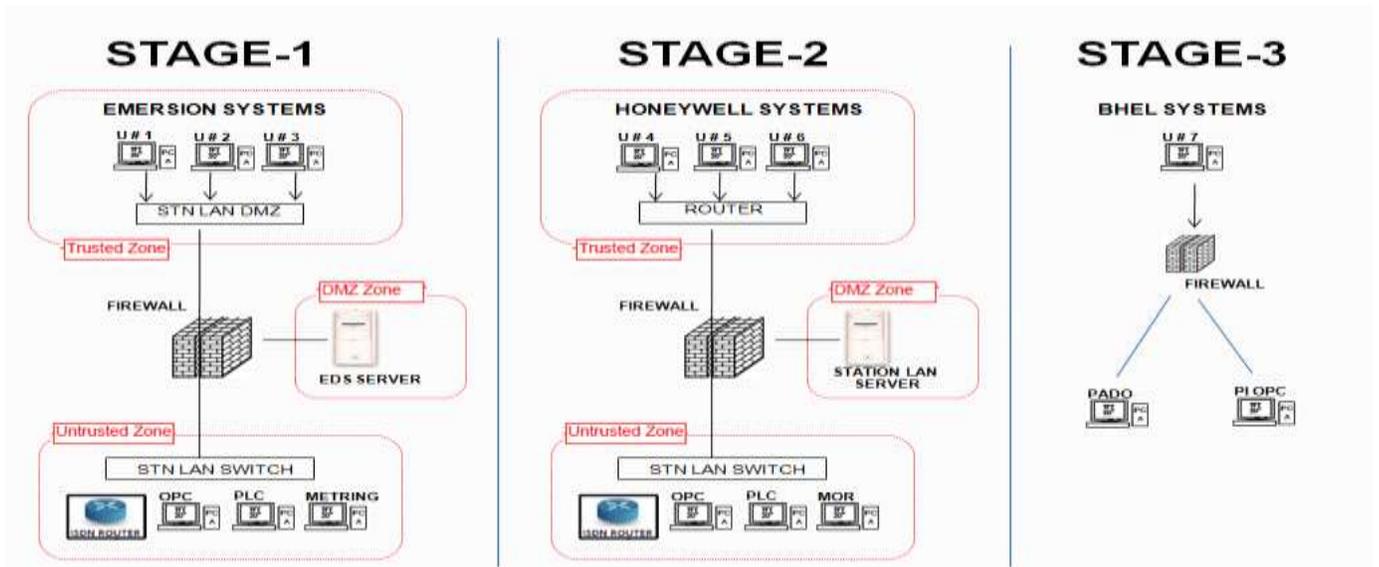


Fig 2: Basic architecture for external communication of DDCMIS systems in RSTPS- Stage wise

The fig2 shows the basic architecture for external communication of DDCMIS systems in each stage. It is evident that all the control systems can be tapped to the external system through the existing firewalls securely by proper settings, however the main challenge is to integrate various control systems of different protocols and to ensure complete security of the system.

#### DIFFERENT OPTIONS AVAILABLE FOR INTEGRATION

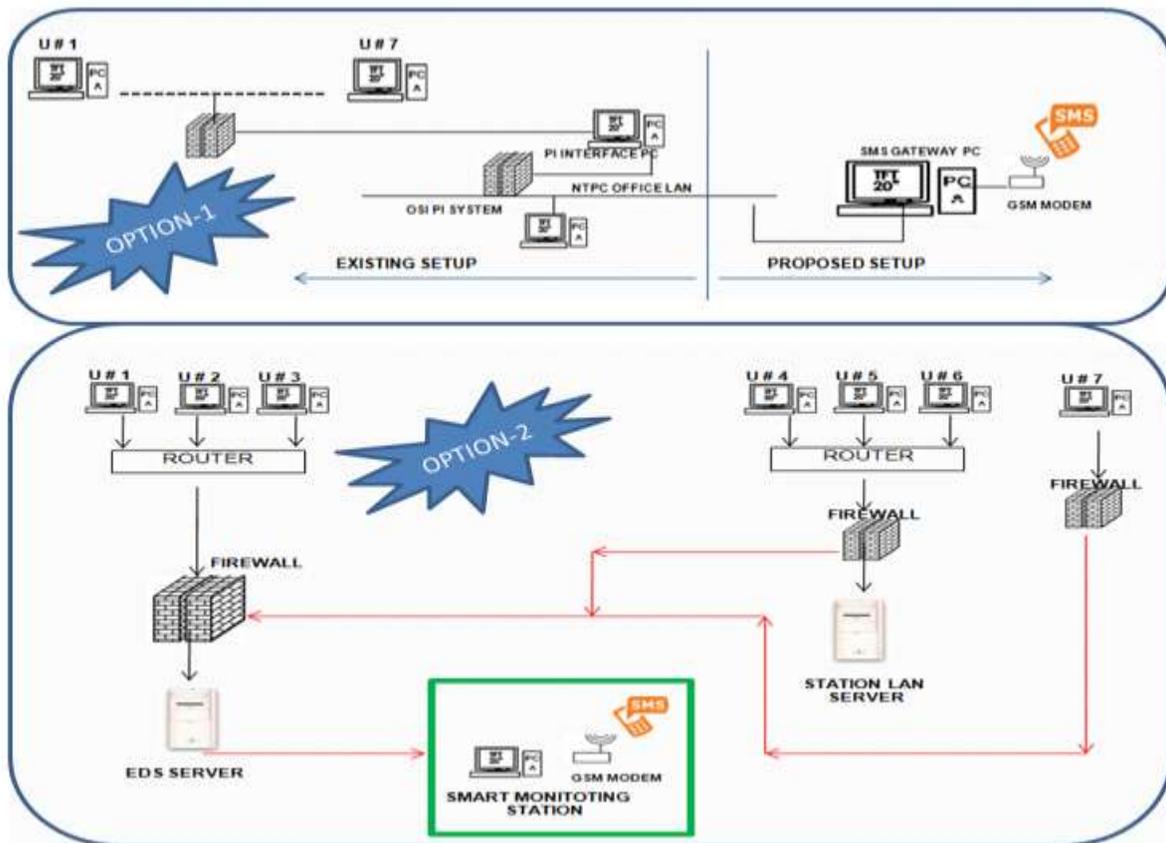


Fig 3: Options for integration different control systems data .

### Option-1: Using Existing PI interface system.

As a part of SAP module, all the important process data of various stations in NTPC are linked with OSI PI system. In Fig 3 ,option-1 shows the proposed configuration. The existing PI is mainly use to monitor and assess the process conditions but not control system data. It requires huge amount of tags to be added in the system. The licence is based on the no of tags used and the tags are nearly consumed. Hence it is nearly impossible to develop the system using this method.

### Option-2: Using Enterprise data server Of Stage-1

The Enterprise data Server supplied with station LAN of Stage-1 systems is having various interface options. The interface from External OPC systems can be made through the EDS OPC application with tunnelling capacity. This configuration is a specific communication through a fixed port in a firewall. This enables to take external data from other DDCMIS systems into Enterprise data server securely. In Fig-3 option-2 shows the possibility of connecting stage 2 & Stage 3 control systems to EDS server via firewall.

## INTEGRATION AND DASHBOARD APPLICATION DEVELOPMENT

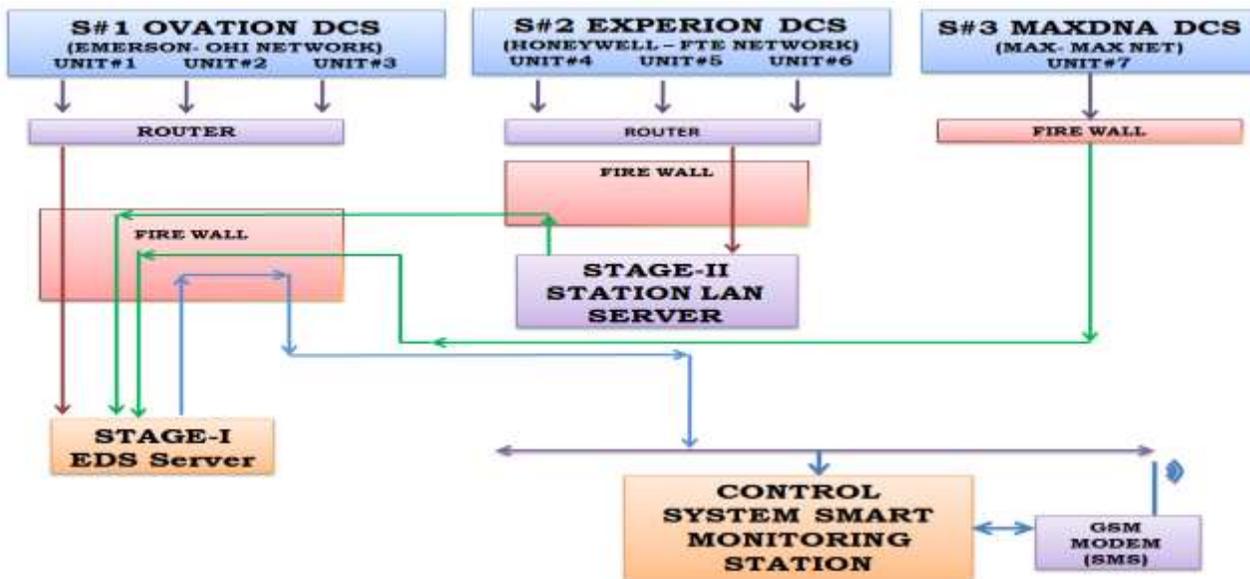


Fig: 4: Functional diagram showing the flow of data to Control system SMART monitoring station

Fig 4 shows the flow of data from stage2 & stage 3 control systems to Stage1 EDS System. The systems diagnosis related data tags from Stage-1 & Stage-2 are available in HMI network. An OPC server is running in each stage which collects data from of the control system on request. An EDS OPC client software with tunneler is installed in respective HMI stations to collect data securely to EDS Server of Stage-1. Appropriate configured ports are opened in firewall to enable secure connection. EDS Server is maintaining the database for the data coming from various systems. A separate Tag name is maintained by EDS data base for every input. EDS Clients can access the data from EDS Server. EDS system is having graphics builder application where a custom graphics can be configured. EDS tags information and attributes can be used with programming languages like Visual Basic to develop customized applications like GSM modem based automatic SMS generation application.

Using EDS Graphics Builder application a dash board covering all the system redundancy faults is developed. Display formatted for large screen 42" display with 1090 x744 pixels resolution.

Fig 5 shows a complete application dashboard for "C&I System Diagnostics with Self Monitoring". The screen covers Controllers, Power supplies, Networks and critical field signal faults for various control systems. Fault Indication is given as an alarm flag with description. For different conditions there will be a change in color of alarm flag. The network communication healthiness for various systems is indicated by a round button.

The green color indicates the healthy condition. Red color indicates the faulty condition in that particular system. Magenta color indicates the communication or configuration fault.

If there is a discrepancy/ fault appears in the particular system, an SMS is generated to the predefined phone number. The Alarm flag will turn to Red and a message indicating the “SMS SENT” is displayed below the flag. The Alarm flag resets to green only after the message is acknowledged to ensure the fault is cleared before sending another message. After acknowledgement the message box “SMS SENT” button “ACK” will disappear.

The alarm is further drilldown to the exact location using the popup screen as shown in the figure

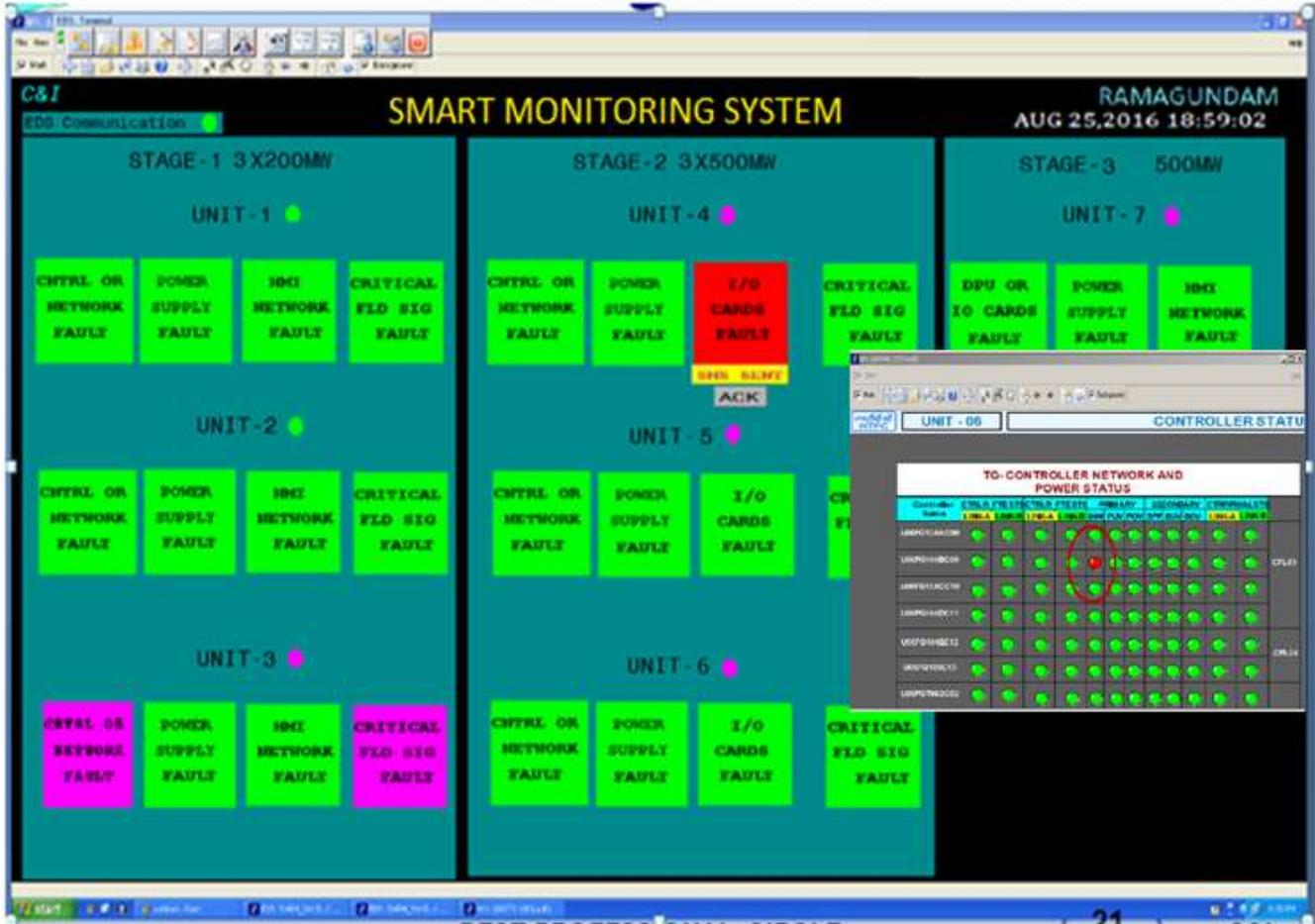
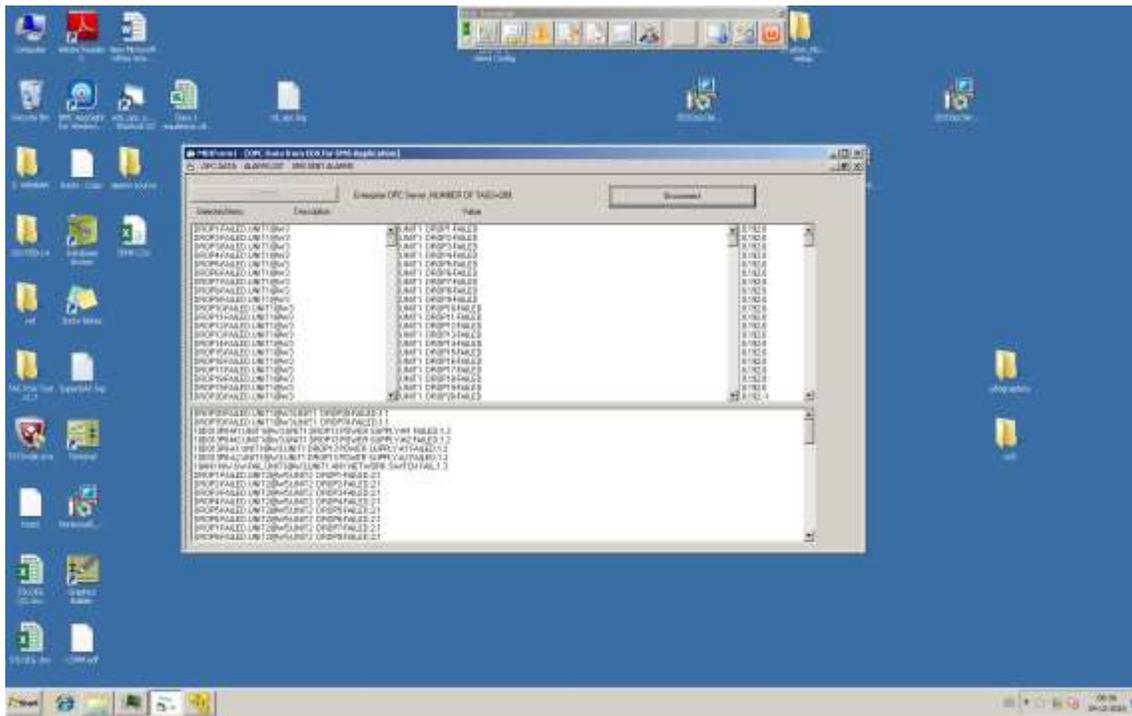


Fig 5: Dashboard for “C&I System Diagnostics with Self Monitoring And Reporting Technology (SMART)”.

### SMS APPLICATION

The development of application involved two modules. The first module is to read status of the control system tags from a VB application (Fig 6 (a)). The data from different control systems is available with EDS server taken for dashboard development as discussed in previous topic. Hence the data can be tapped from EDS OPC Server. An OPC Client module is developed using standard library files available from OPC foundation website. This module scans the predefined points defined in "taglist.ini" configuration file (Fig 6 (b)). The attribute like tag, description, true bit, area can be set in this configuration file. Any addition of tags are done in this file.

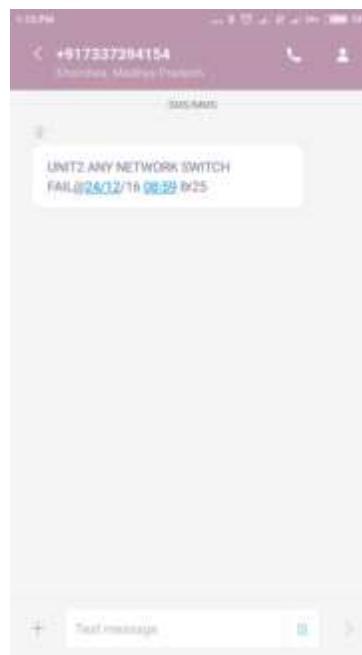
The second module is an SMS module developed by using AT commands to communicate with GSM modem. The defined parameters tag list is scanned every minute. In case of any abnormal condition of control system an SMS is generated (Fig 6(C)) with a description defined in configuration file. The numbers to which SMS needs to be sent can be configured in "numbers.ini" file. The same alarm is also reflected in the dashboard, indicating the delivery of the SMS. The abnormality can to be acknowledged and reset after fault rectification via return SMS or through Dashboard. The logging of various SMS sent is done in a text file for future reference and troubleshooting (Fig 6(d)).



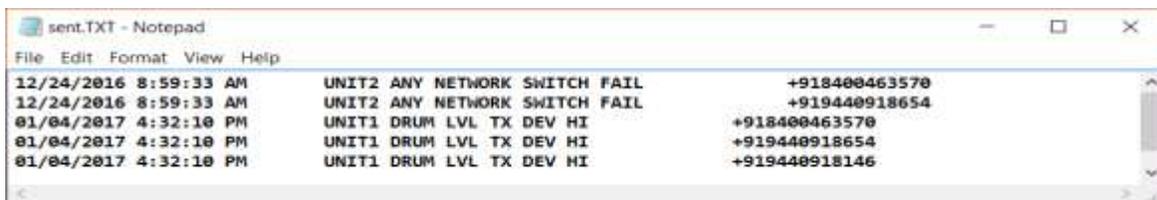
(a) OPC Client with SMS service Application



(b) Configuration file



(c) SMS received in mobile



(d) SMS log file

Fig 6: Screen Shots of SMS Application

## **CONCLUSION**

This "C&I System Diagnostics with Self Monitoring And Reporting Technology (SMART) " is one stop solution for controlling C&I System faults of a power station and thereby reduces the spurious outages, unwanted generation losses due to any kind of redundancy failure in C&I control system. This kind of system is useful in any kind of power station where a single point self monitoring is possible by integrating all the available control systems, thereby reducing the O&M costs.