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Integrated Approach to Avoid Power Outages using Distributed Control System(DCS)

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Abstract

In Olympics season, India has been on a record-breaking spree. Monday's power outage, which affected 370 million people after the Northern Grid collapsed, beat the Java-Bali outage in Indonesia which had affected 100 million people in August, 2005. But India's Power department is on a roll. It broke Monday's record the very next day. Collapse of the Northern, Eastern and North-Eastern grids threw 600 million people out of power. As hundreds of long-distance, sub-urban and urban trains came to a halt, bank ATMs stopped functioning. While scheduled surgeries were cancelled (till the generators started running), work at small businesses and offices came to a standstill. People struggled to get back home as public transport platforms proved to be inadequate. Looking at the number of lives affected, it is unlikely that this record will ever be broken. Six hundred million is more than the population of the two Americas taken together. In this paper I have proposed an integrated approach in avoiding power outages using Distributed Control System thereby eliminating such large power outages and lighting the nation with automation. ***Should our powerful nation go without power?***

Keywords—*Power outage; grid failure; Distributed Control System; redundancy*

1. Introduction

A Distributed Control System (DCS) is a distributed control and centralized monitoring system. It usually refers to a control system of a manufacturing process or any kind of dynamic system, in which the controller elements are not central in location (like the brain) but are distributed throughout the system with each component sub-system controlled by one or more controllers. The entire system of controllers is connected by networks for communications and monitoring.

- Control function is distributed among multiple CPUs. Hence the failure of one CPU doesn't affect the entire plant.
- Redundancy is available at various levels.
- Field wiring required is considerably less.
- Cost effective in long run
- Maintenance and troubleshooting becomes very easy.

Keeping these advantages in mind, DCS is a very broad term used in a society of industries, to monitor and control distributed equipment. Few of them are:

- Electrical power grids and electrical generation plants.
- Environmental control systems
- Oil refining plants
- Metallurgical process plants
- Chemical plants
- Pharmaceutical plants
- Dry cargo and oil carrier ships.

2. Elements of DCS

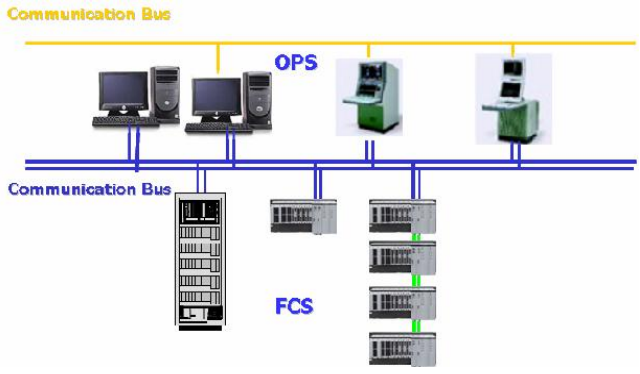

Fig.1. Elements of DCS

There are three main elements in DCS and they are as follows:

- Field control station
- Operator station/Human Interface Station
- Communication bus

2.1 FCS (Field Control Station):

The Field Control Station is used to control the process. All the instruments and interlocks created by software reside in the memory of the FCS. All the field instruments like transmitters and control valves are wired to the FCS.

2.2 OPS (Operator Station):

The operator station is used to monitor the process and to operate various instruments.

2.3 Communication Bus:

Communication bus is used to communicate between the Field Control Station and the Operator station.

3. Current scenario in Power Transmission

India consists of five regional grids such as northern grid, eastern grid, western grid, southern grid and northeastern grid which covers all states of our nation. Every grids are interconnected except southern grid. About thirty percent of power generated is wasted during transmission. Poor maintenance of metering devices and National load dispatch centre has been connected with five regional dispatch centres through which power is transmitted to each of the State electricity boards.The grid is maintained at the maximum frequency of 50.4 Hz. The present transmission system has to meet the firm transmission needs as well as open access requirements. The Long term Access (LTA) gives the transmission system strengthening required for future generation additions and the Short Term Open Access (STOA) facilitates increased real time trading in electricity, utilizing the inherent margins provided for required redundancies as per planning criteria. The STOA leads to market determined generation dispatches resulting in supply at reduced prices to the distribution utilities and ultimately to the consumers. There is no distributed control in present transmission systems which leads to outage that appeared on 30 July 2012 leaving almost half of the nation's population in dark and another major cause is the failure to meet sudden demands from various states

3.1 Transmission System Development - Issues

As mentioned above, in order to meet growing requirement, development of strong transmission system between pit-head/resource generation complex and bulk consumption centres are required. However, development of transmission system involves following issues:

- Minimization of Right of Way
- Protection of flora & fauna, wild life
- Creation of long distance high capacity transmission corridors to enable minimum cost per MW transfer as well as Optimal Transmission losses
- Minimal Impact on Environment
- Strengthening of National Grid

4. Proposed Methodology

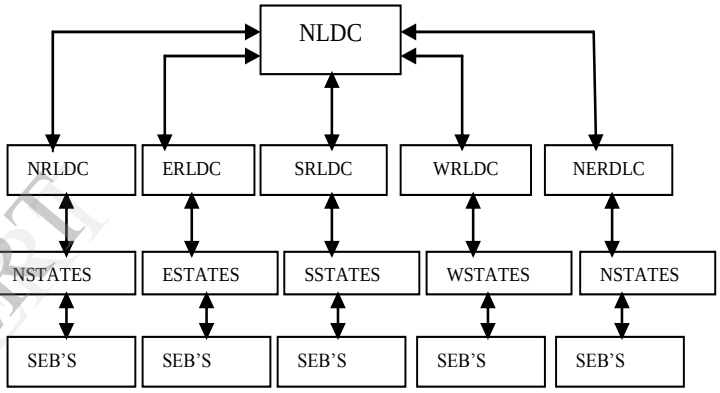

Fig.2.Overall architecture

Keywords- National Load Dispatch Centre (NLDC), Northern Regional Load Dispatch Centre (NRLDC), Eastern Regional Load Dispatch Centre (ERLDC), Southern Regional Load Dispatch Centre (SRLDC), Western Regional Load Dispatch Centre (WRLDC), North Eastern Regional Load Dispatch Centre (NERLDC), State Electricity Board (SEB).

All the five grids are interconnected with the central grid and all the state electricity boards are connected with the regional grids. Our Proposed approach is to connect entire system in Distributed Control System (DCS) which ensures safe operation and redundant in various stages of transmission. The control function is distributed and any failure in a particular grid does not

affect other grids avoiding outages as happened earlier. Our proposed idea is based on simulation in Yokogawa Centum Vp. Every grid has separate DCS

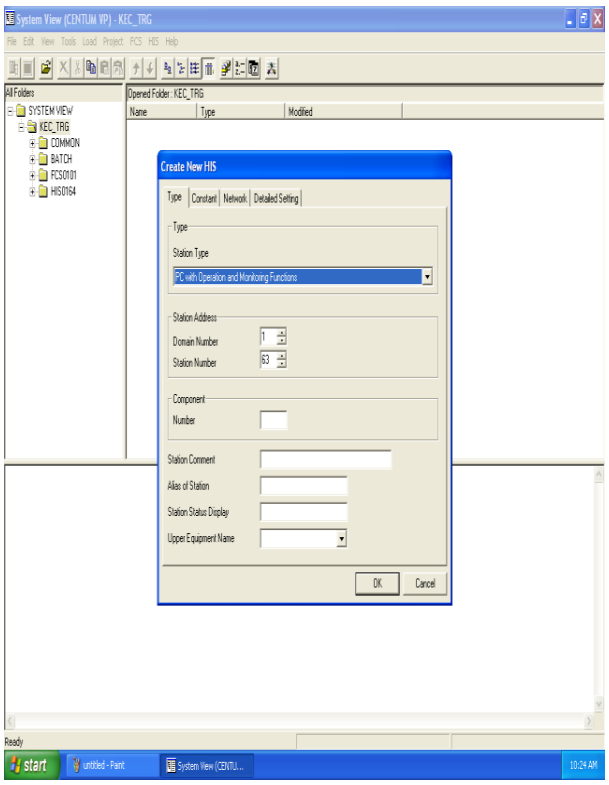

Fig.3.Project creation in DCS

Analog and digital channels must be configured in the operator station and the same must be connected in respective input/output cards.IOM builder in centum vp is used to configure the input/output with control system.

CENTUM VP System Capacity

Maximum number of stations per domain	64 stations
Maximum number of HIS per domain	16 stations
Station number for HIS	1 to 64 in descending order
Station number for FCS	1 to 64 in ascending order
Maximum number of domains	16 per system
Numbering of domains	1 to 64
Maximum number of stations per system	256 per system

4.1 IOM Builder:

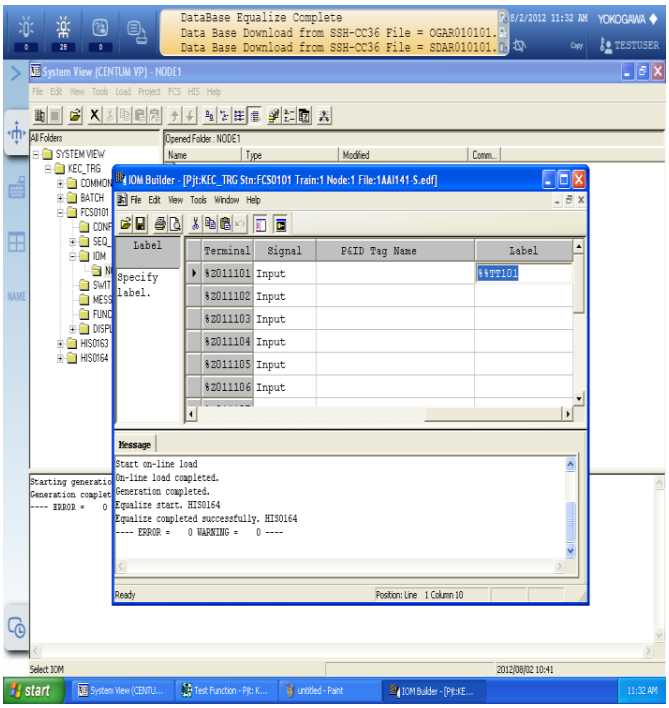

Fig.4.IOM builder window

IOM Builder is used to configure corresponding inputs and outputs connected to field control station of DCS. Process inputs and outputs signals are exchanged between field equipment and field control station via I/O cards placed in the node interface units. Analog I/O, Digital I/O and Communication I/O are the three process inputs and outputs.

4.2 Functional block

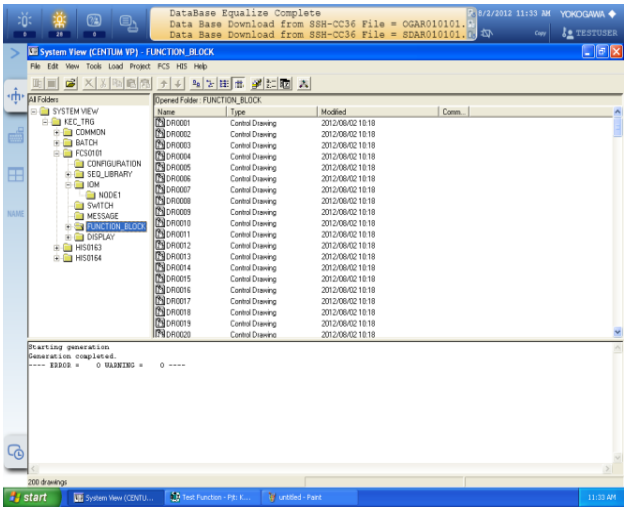

Fig.5.Functional block

Functional block is used to program the control system for effective control of transmission system. Programming in centum Vp is easy and it has in-built fuctional blocks that performs specific fuctions.It has graphical representation to promote easy access and understanding of the process.Fuctional block consists of around 200 control drawing in which any number of drawings can be built using few in-built functions such as PID,PIO,PVI,ST16,RL blocks. PID block acts as controller for processing and initiating control action. PIO blocks are process inputs and outputs which is connected to PID block as respective inputs and outputs. PVI block is used to indicate the value of process variable connected to it. ST16 block is used to program logical sequence as required for alarm creation.

4.3 Programming for Transmission outage

Control drawing builder is used to program the DCS. National Load Dispatch Centre is connected to various grids across the nation which distributes the power to entire nation thus providing distributed control. All five grids are connected to corresponding state electricity boards. Maximum demands of each state at various seasons are calculated and fed to grid as set point value. National Load Dispatch Centre receives various maximum limits of each grid capacity. When demands of any of grid increases than preset value, alarms and annunciation is created.

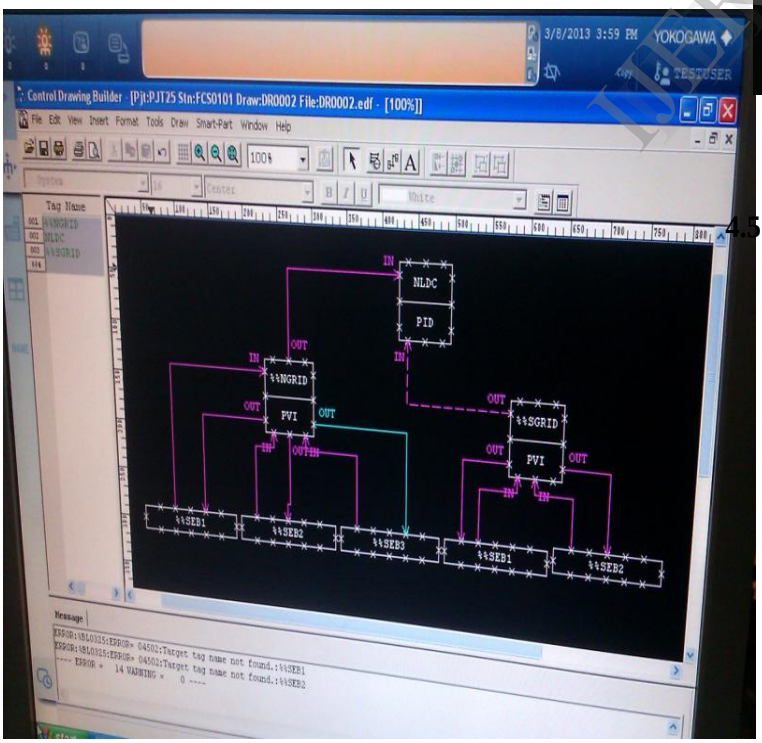

Fig.6.Control drawing builder

4.4 Sequential operation for Safety

Sequential block is created using ST16 in which option edit detail option is used to program the sequential operation program. In this program, for example if Northern grid exceeds the prescribed limit of its demand though Southern grid is in normal load consumption i.e., southern is within the prescribed limits of the demand the Alarm and annunciation system is created and a message is sent to northern grid to reduce sudden load fluctuations thereby preventing collapse of other regional grids.

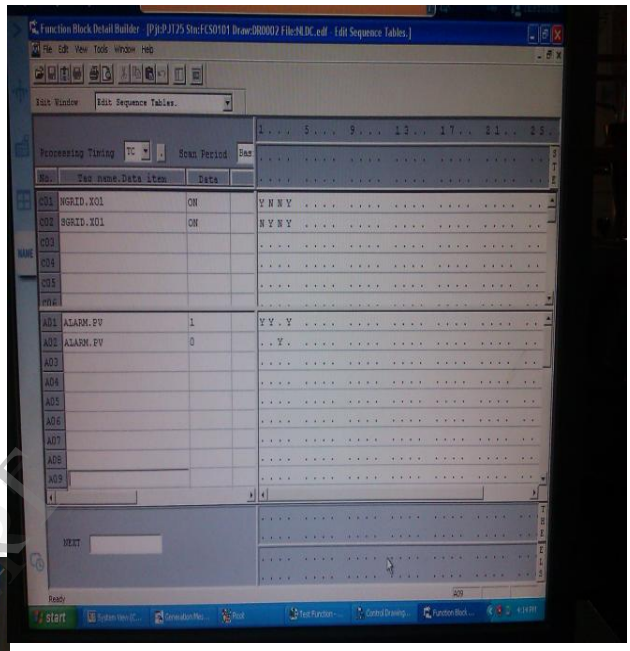

Fig.7.Sequential operation

4.5 Alarm and annunciations

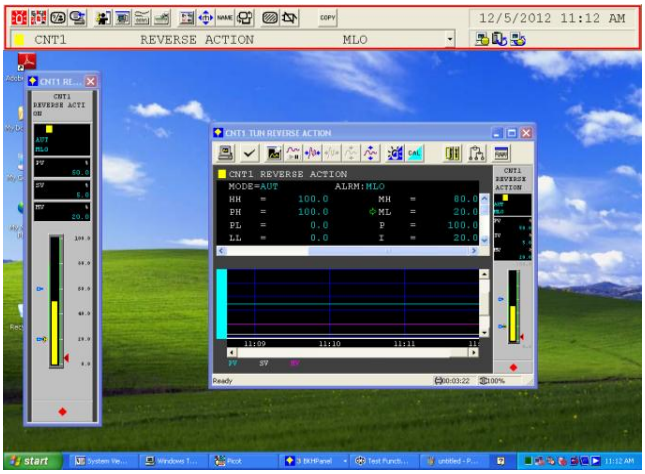

Fig.8.Alarm window

4.6 Message Processing

The message processing feature of CENTUM VP notifies the operator of the status change of process and system using messages. The software supports various user defined messages.

They are:

- Annunciation Message
- Operator Guide Message
- Print Message
- Sequence Message Request
- Signal Event Message
- Help Message

5. BENEFITS OF USING GRAPHICAL SYSTEM DESIGN APPROACH

- Programming knowledge is not required. So a lay man can also work in the system.
- Control function is distributed among multiple CPUs.
- Errors can be easily identified by alarms and notifications.
- Redundancy is available at various levels.
- Cost effective in long run.
- Maintenance becomes very easy.
- No man power required.
- Job can be completed easily
- Quality of the product becomes best.

6. CONCLUSION

The implementation of the new capabilities of the integrated process control systems will allow the power sector to optimize their energy consumption and improve operational efficiencies throughout their additional facilities. The integration of energy and asset management information is now available in one central location, increasing the operability and transmission cost of operation. It is not a question of whether or not power sector will embrace new technologies; the sector economics will make it inevitable. Those facilities that will embrace new technologies will be in a better position to accelerate market shares and increase profit margins.

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