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Distributed Control Systems & it's Industrial Applications

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ABSTRACT: To explain the design of distributed Control System and it's industrial Applications.

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I. INTRODUCTION

The DCS is the system of sensors, controllers and associated computers that aare distributed throughout the plant. Each of these elements serve a unique purpose such as data acquisition.

Distributed control systems first emerged in large, high value, safety critical process industries, and were attractive because the DCS manufacturer would supply both the local control level and central supervisory equipment as an integrated package, thus reducing design integration risk.

Today the functionality of SCADA and DCS systems are very similar, but DCS tends to be used on large continuous process plants where high reliability and security is important, and the control room is not geographically remote.

The introduction of DCSs allowed easy interconnection and re-configuration of plant controls such as cascaded loops and interlocks, and easy interfacing with other production computer systems. It enabled sophisticated alarm handling, introduced automatic event logging, removed the need for physical records such as chart recorders, allowed the control racks to be networked and thereby located locally to plant to reduce cabling runs, and provided high level overviews of plant status and production levels.

Digital communication between distributed controllers, workstations and other computing elements (peer to peer access) was one of the primary advantages of the DCS. Attention was duly focused on the networks, which provided the all-important lines of communication that, for process applications, had to incorporate specific functions such as determinism and redundancy. As a result, many suppliers embraced the IEEE 802.4 networking standard. This decision set the stage for the wave of migrations necessary when information technology moved into process automation and IEEE 802.3 rather than IEEE 802.4 prevailed as the control LAN.

In the 1980s, users began to look at DCSs as more than just basic process control. A very early example of a Direct Digital Control DCS was completed by the Australian business Midac in 1981–82 using R-Tec Australian designed hardware. The system installed at the University of Melbourne used a serial communications network, connecting campus buildings back to a control room "front end". Each remote unit ran two Z80 microprocessors, while the front end ran eleven Z80s in a parallel processing configuration with paged common memory to share tasks and that could run up to 20,000 concurrent control objects.

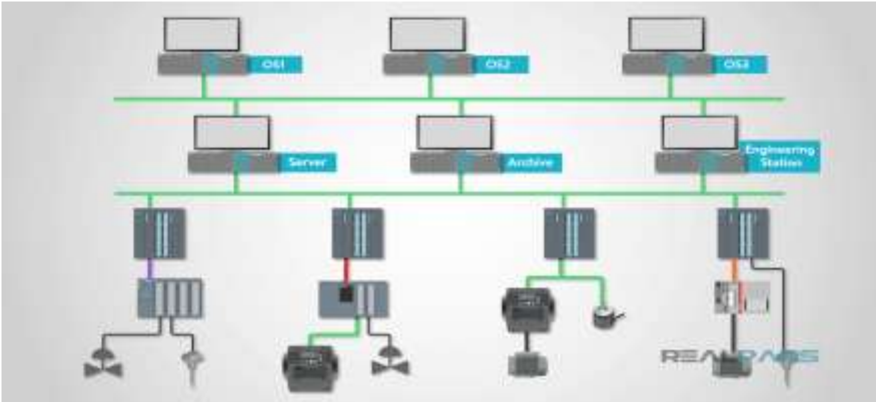
The latest developments in DCS include the following new technologies:

1. Wireless systems and protocols
2. Remote transmission, logging and data historian
3. Mobile interfaces and controls
4. Embedded web-servers

Increasingly, and ironically, DCS are becoming centralized at plant level, with the ability to log into the remote equipment. This enables operator to control both at enterprise level and at the equipment level (micro), both within and outside the plant, because the importance of the physical location drops due to interconnectivity primarily thanks to wireless and remote access.

The more wireless protocols are developed and refined, the more they are included in DCS. DCS controllers are now often equipped with embedded servers and provide on-the-go web access. Whether DCS will lead Industrial Internet of Things (IIOT) or borrow key elements from remains to be seen.

Many vendors provide the option of a mobile HMI, ready for both Android and iOS. With these interfaces, the threat of security breaches and possible damage to plant and process are now very real.



There are four basic elements of Distributed control systems

1. Engineering PC or controller
2. Distributed controller or Local control unit
3. Operating station or HMI
4. Communication media and protocol

1. Engineering PC or controller

This controller is the supervisory controller over all the distributed processing controllers. Control algorithms and configuration of various devices are executed in this controller. Network communication between processing and engineering PC can be implemented by simplex or redundant configurations.

2.Distributed controller or Local control unit

It can be placed near to field devices (sensors and actuators) or certain location where these field devices are connected via communication link. It receives the instructions from the engineering station like set point and other parameters and directly controls field devices.

It can sense and control both analog and digital inputs / outputs by analog and digital I/O modules. These modules are extendable according to the number of inputs and outputs. It collects the information from discrete field devices and sends this information to operating and engineering stations.

In above figure AC 700F and AC 800Fcontrollers acts as communication interface between field devices and engineering station. Most of the cases these act as local control for field instruments.

3.Operating station or HMI

It is used to monitor entire plant parameters graphically and to log the data in plant database systems. Trend display of various process parameters provides the effective display and easy monitoring.

These operating stations are of different types such as some operating stations (PC's) used to monitor only parameters, some for only trend display, some for data logging and alarming requirements. These can also be configured to have control capabilities.

4.Communication media and protocol

Communication media consists of transmission cables to transmit the data such as coaxial cables, copper wires, fiber optic cables and sometimes it might be wireless. Communication protocols selected depends on the number of devices to be connected to this network.

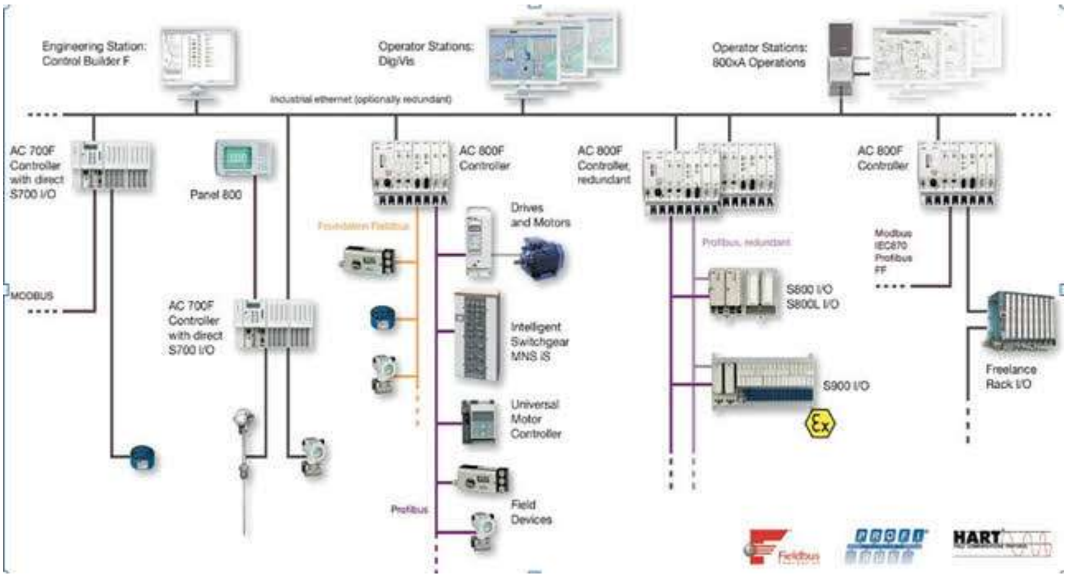
For example, RS232 supports only for 2 devices and Profibus for 126 devices or nodes. Some of these protocols include Ethernet, DeviceNet, foundation filed bus, modbus, CAN, etc.

In DCS, two or more communication protocols are used in between two or more areas such as between field control devices and distributed controllers and other one between distributed controllers and supervisory control stations such as operating and engineering stations.

Features of DCS:

- To handle complex processes
- System redundancy
- Lot of Predefined function blocks
- More sophisticated HMI
- Scalable platform
- System security

DCS Functions:



- **DCS** works as a tool to control a loop system where one loop can happen some control process.
- Working as a replacement of separate manual and auto control tools to be a unity to be easier for maintenance and use
- Data and data collection means to be obtained a really desired process.

DCS Philosophy in The Planning:

- integration
- distribution
- reliability
- openness
- user-friendliness
- investment security & expandability

Working of DCS:

DCS as an automatic control system works in a way

- Collect data received from the field
- Processing the data into a standard signal
- Processing standard signal data obtained with the applicable control system so that it can be applied to obtain a suitable value for signal correction.
- If there is an error or data deviation, then correction is made from the data obtained in order to reach the intended standard value
- After a correction from the data, a deviation occurs a measurement or data collection is performed from the field

II. INDUSTRIAL WORKING OF DCS

The basic functionality of the DCS is "The work is distributed depending upon the functionality." The DCS is said to have a layered structure. Each layer corresponds to a group of group of functions to be performed on lower layer, on getting some instructions from the higher layer and each layer can work independent.

One of the DCS used in HPCL-VR is supplied by Yokogawa India Limited (YIL) and its system configuration is as follows:

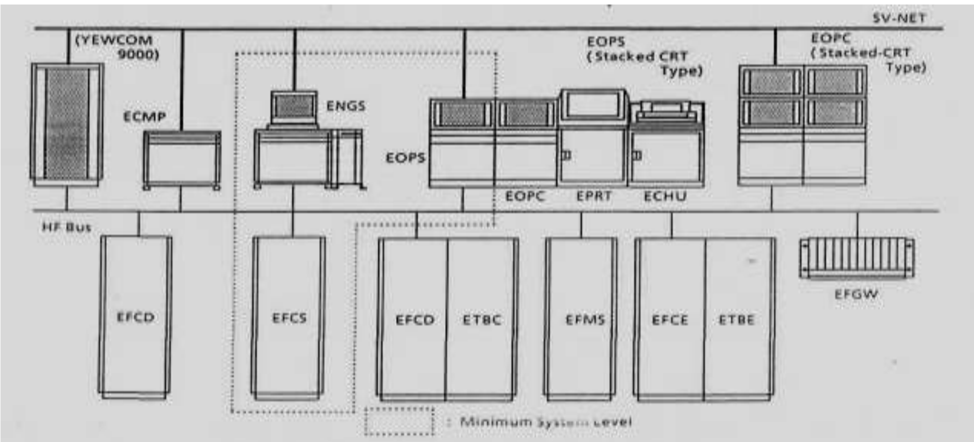


Figure 1.1 CENTUM-XL System Configuration Diagram

ENGS: Engineering Station
EOPC: Operator Console
EPRT: Serial Printer
EFCS: Field Control Station
ETBC: Terminal Board Cabinet
EFCE: Duplexed Field Control Station
ETBE: Terminal Board Cabinet
EFMS: Field Monitoring Station
EOPS: Enhanced Operator Station
ECMP: Computer Station
ECHU: Color Hard Copy Unit
EFCD: Duplexed Field Control
EFGW: Field Gateway Unit

The experimental setup consists mainly of three parts; humidifier-dehumidifier section, saline water cycle, and cooling water cycle as shown in Fig. 1.The humidifier-dehumidifier tank was manufactured from steel. It consists of built in double tank; the outer tank has 80 cm diameter and 200 cm length and the inner tank has 60 cm diameter and 170 cm length. The gap between double tanks to collect the fresh water condensate, the hot saline water pressured in the nozzles in the inner tank to evaporate, also, then the cold spherical dome condensate the fresh vapor and drag to collect it as a water drop on the inner surface of the spherical dome to collect it in the gap.The non-evaporated saline returns back to level controlled tank to pressure it to the collector.

Advantages of DCS systems

The major advantages of functional hardware distribution are flexibility in system design, ease of expansion, reliability, and ease of maintenance. A big advantage compared to a single-computer system is that the user can start out at a low level of investment. Another obvious advantage of this type of distributed architecture is that complete loss of the data highway will not cause complete loss of system capability. Often local units can continue operation with no significant loss of function over moderate or extended periods of time.

Moreover, the DCS network allows different modes of control implementation such as manual/auto/supervisory/computer operation for each local control loop. In the manual mode, the operator manipulates the final control element directly. In the auto mode, the final control element is manipulated automatically through a low-level controller usually a PID. The set point for this control loop is entered by the operator. In the supervisory mode, an advanced digital controller is placed on the top of the low-level controller (Figure 1). The advanced controller sets the set point for the low-level controller. The set point for the advanced controller can be set either by the operator or a steady state optimization. In the computer mode, the control system operates in the direct digital mode.

One of the main goals of using DCS system is allowing the implementation of digital control algorithms. The benefit of digital control application can include:

Digital systems are more precise.

Digital systems are more flexible. This means that control algorithms can be changed and control configuration can be modified without having rewiring the system.

Digital system cost less to install and maintain.
Digital data in electronic files are easier to deal with. Operating results can be printed out, displayed on colour terminals, stored in highly compressed form

III. CONCLUSION

The Distributed Control System has come a long way from proprietary, large systems of the past to being scalable to meet a wide range of applications. Many industrial operations that typically use PLCs should consider what's available to them in current, state-ofthe-art DCS solutions.

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