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Review Article

DCS SYSTEM A NEW REVOLUTION IN PHARMA SECTOR

Ladi Alik Kumar

Assistant Professor, School of Pharmacy, Centurion University, Rayagada, Odisha- 765022, INDIA.

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ABSTRACT

As the name implies, the DCS is a system of sensors, controllers, and associated computers that are distributed throughout a plant. Each of these elements serves a unique purpose such as data acquisition, process control, as well as data storage and graphical display. These individual elements communicate with a centralized computer through the plant's local area network – often referred to as a control network. As the 'central brain' of the plant the DCS makes automated decisions based on production trends it sees them in real-time throughout a plant. The DCS concept increases reliability and reduces installation costs by localising control functions near the process plant, with remote monitoring and supervision. In recent years, the use of smart devices and field buses makes distributed control system (DCS) to be prominent in large and complex industrial processes as compared to the former centralized control system. This distribution of control system architecture around the plant has led to produce more efficient ways to improve reliability of control, process quality and plant efficiency. Nowadays, distributed control system has been found in many industrial fields such as chemical plants, oil and gas industries, food processing units, nuclear power plants, water management systems, automobile industries, etc. Mainly the role of DCS system in Pharma sector was more prominent service.

KEYWORDS: *Architecture of DCS, Engineering work station, Operating station, Communication system, Smart and intelligent system, Working and operation of DCS.*

INTRODUCTION

A Distributed Control System (DCS) is a computerised control system for a process or plant usually with a large number of control loops, in which autonomous controllers are distributed throughout the system, but there is central operator supervisory control. This is in contrast to systems that use centralized controllers; either discrete controller located at a central control room or within a central computer [11].

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 [12].

It differs from the centralized control system wherein a single controller at central location handles the control function, but in DCS each process element or machine or group of machines is controlled by a dedicated controller. DCS consists of a large number of local controllers in various sections of plant control area and are connected via a high speed communication network [12].

In DCS control system, data acquisition and control functions are carried through a number of DCS controllers which are microprocessor based units distributed functionally and geographically over the plant and are situated near area where control or data gathering functions being performed as shown in the figure above. These controllers able to communicate among themselves and also with other controllers like supervisory terminals, operator terminals, historians, etc [13].

Distributed individual automatic controllers are connected to field devices such as sensors and actuators. These controllers ensure the sharing of gathered data to other hierarchal controllers via different field buses. Different field buses or standard communication protocols are used for establishing the communication between the controllers. Some of these include Profibus, HART, arc net, Modbus, etc [2].

DCS is most suited for large-scale processing or manufacturing plants wherein a large number of continuous control loops are to be monitored and controlled. The main advantage of dividing control tasks for distributed controllers is

*** Corresponding author:**

Ladi Alik Kumar

Assistant Professor,

School of Pharmacy, Centurion University,

Rayagada, Odisha- 765022, INDIA.

** E-Mail: alikkumar3@gmail.com*

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that if any part of DCS fails, the plant can continue to operate irrespective of failed section [3].

How is a DCS Used?

While DCSs are used across the process control industries to supervise complex production processes, they are more widely deployed at large, continuous manufacturing plants such as in pharmaceutical industry. With the help of a DCS these and other manufactures can efficiently coordinate adjustments in a top-down fashion using a centralized network of computers. Instructions from the DCS are deployed throughout a plant and fed to individual controllers. When configured appropriately the DCS can improve safety while also enhancing production efficiency [6].

What Makes the DCS so Important?

A comparison of two plants may help to illustrate the importance of the DCS. First, imagine a small municipal waste water treatment facility that employs a dozen control loops. The plant's engineering staff can easily keep a mindful eye on the performance of such a limited number of controllers. Next, imagine a large refinery that operates 10,000 highly dynamic and interacting control loops. While coordinating control at the treatment facility is relatively easy, the task of orchestrating control at the refinery can be overwhelming without the use of a DCS [6].

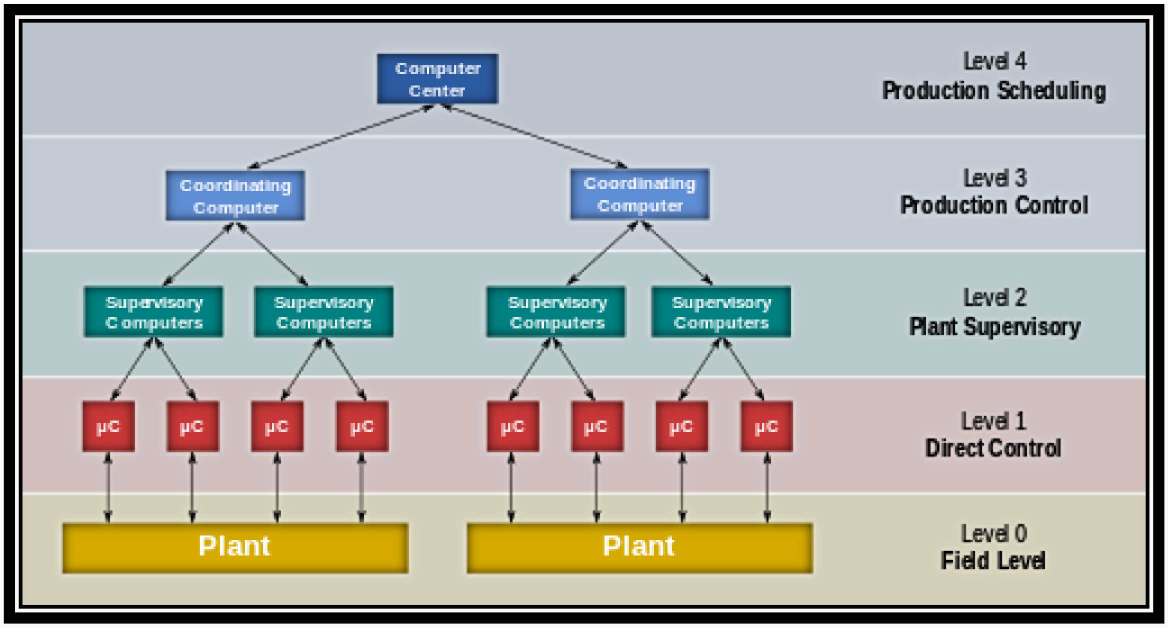

Fig. 2: Functional levels of a manufacturing control operation

Functional levels of a manufacturing control operation:

The key attribute of a DCS is its reliability due to the distribution of the control processing around nodes in the system. This mitigates a single processor failure. If a processor fails, it will only affect one section of the plant process, as opposed to a failure of a central computer which would affect the whole process. This distribution of computing power local to the field Input/Output (I/O) connection racks also ensures fast controller processing times by removing possible network and central processing delays [4, 5].

The accompanying diagram is a general model which shows functional manufacturing levels using computerised control.

Referring to the diagram;

- Level 0 contains the field devices such as flow and temperature sensors, and final control elements, such as control valves
- Level 1 contains the industrialised Input/Output (I/O) modules, and their associated distributed electronic processors.
- Level 2 contains the supervisory computers, which collect information from processor nodes on the system, and provide the operator control screens.
- Level 3 is the production control level, which does not directly control the process, but is concerned with monitoring production and monitoring targets
- Level 4 is the production scheduling level.

Levels 1 and 2 are the functional levels of a traditional DCS, in which all equipment are part of an integrated system from a single manufacturer.

Levels 3 and 4 are not strictly process control in the traditional sense, but where production control and scheduling takes place [11, 12].

Architecture of Distributed Control System:

As the name suggests, DCS has three main qualities. The first one is the distribution of various control functions into relatively small sets of subsystems, which are of semiautonomous, and are interconnected through a high speed communication bus. Some of these functions include data acquisition, data presentation, process control, process supervision, reporting information, storing and retrieval of information [1, 3].

The second attribute of DCS is the automation of manufacturing process by integrating advanced control strategies. And the third characteristic is the arranging the things as a system [8, 11].

DCS organizes the entire control structure as a single automation system where various subsystems are unified through a proper command structure and information flow. These attributes of DCS can be observed in its architecture shown in the diagram below. The basic elements comprised in a DCS include engineering workstation, operating station or HMI, process control unit or local control unit, smart devices, and communication system [12, 13].

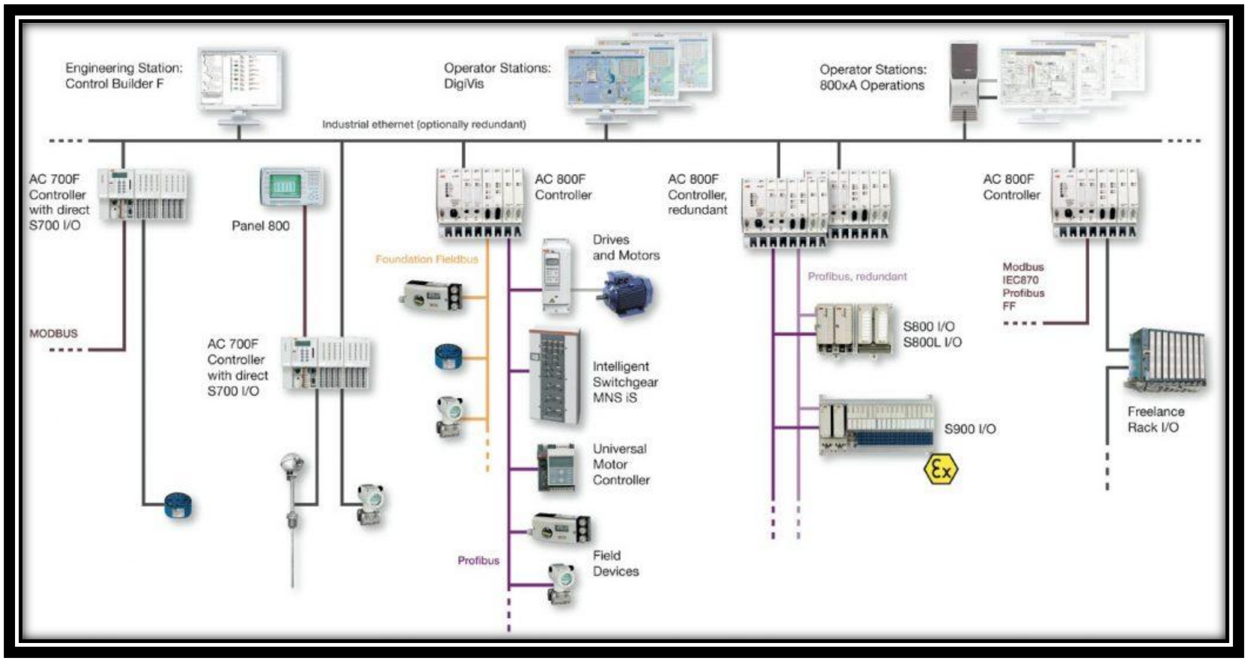

Fig. 2: Architecture of Distributed Control System

Engineering Workstation:

It is the supervisory controller over the entire distributed control system. It can be a PC or any other computer that has dedicated engineering software (for example, control builder F engineering station in case of ABB freelance distributed control system).

This engineering station offers powerful configuration tools that allow the user to perform engineering functions such as creating new loops, creating various input and output points, modifying sequential and continuous control logic, configuring various distributed devices, preparing documentation for each input/output device, etc [3, 8].

Operating Station or HMI:

This is used to operate, monitor and control plant parameters. It can be a PC or any other monitoring device that has a separate software tool on which operator can view process parameter values and accordingly to take control action. For instance, it is a DigiVis software tool that can run on a simple PC-environment in case ABB DCS [7, 8].

Operating stations can be a single unit or multiple units where a single unit performs functions like parameter value display, trend display, alarming, etc. while multiple units or PCs performs individual functions such as some PCs display parameters, some for trend archives, some for data logging and acquiring, etc.

Communication System:

The communication medium plays a major role in the entire distributed control system. It interconnects the engineering station, operating station, process station and smart devices with one another. It carries the information from one station to another. The common communication protocols used in DCS include Ethernet, Profibus, Foundation Field Bus, DeviceNet, Modbus, etc [6, 9].

It is not mandatory to use one protocol for entire DCS, some levels can use one network whereas some levels use different network. For instance, consider that field devices, distributed I/Os and process station are interconnected with Profibus while the communication among engineering station, HMI and process station carried though Ethernet as shown in the figure below [5, 9].

The major advantage of DCS is the redundancy of some or all levels of the control area. Most of the cases critical processes are installed with redundant controllers and redundant communication networks such that problem in main processing line should not affect the monitoring and control functions because of the redundant processing section [11, 13].

Smart or Intelligent Devices:

The intelligent field devices and field bus technology are advanced features of DCS technology that replaces traditional I/O subsystems (I/O modules). These smart devices embed the intelligence required for simple sensing and control techniques into the primary sensing and actuating devices. And hence it replaces the need for a DCS controller to perform routine sensing and control process [5, 11].

These field devices can be directly connected to field bus so that sourcing of multiple measurements to the next higher level control station is possible via digital transmission line by eliminating extraneous hardware such as local I/O modules and controllers [8, 12].

Fig. 3: Smart or Intelligent Devices

Working & Operation of DCS System:

The operation of DCS goes like this; Sensors senses the process information and send it to the local I/O modules, to which actuators are also connected so as to control the process parameters. The information or data from these remote modules is gathered to the process control unit via field bus. If smart field devices are used, the sensed information directly transferred to process control unit via field bus [7, 9].

Fig. 4: Working & Operation of DCS System

The collected information is further processed, analyzed and produces the output results based on the control logic implemented in the controller. The results or control actions are then carried to the actuator devices via field bus. The DCS configuring, commissioning and control logic implementation are carried at the engineering station as mentioned earlier. The operator able to view and send control actions manually at operation stations [12, 13].

Fig. 5: Examples of DCS

Features:

Distribution Control Systems (DCS) can be used in various control applications with more number of I/O's with dedicated controllers. These systems are used in manufacturing processes where designing of multiple products in multiple procedures such a batch process control.

Modern systems (2010 onwards):

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 centralised at plant level, with the ability to log into the remote equipment. This enables operator to control both at enterprise level (macro) and at the equipment level (micro) both within and outside the plant as physical location due to interconnectivity primarily due to wireless and remote access has shrunk [9, 10].

As wireless protocols are developed and refined, DCS increasingly includes wireless communication. DCS controllers are now often equipped with embedded servers and provide on-the-go web access. Whether DCS will lead IIOT or borrow key elements from remains to be established [9, 10].

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.

CONCLUSION

The distributed control system, distribute memory and the shared memory management system reduce the complexity of control system design [7].

The virtual wire hardware uses time multiplexing to decrease the size and complexity of the programmable resources on the platform conserving the cheap area for other valuable logic resources [7].

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 of the art DCS solutions.

It also helps in • Expedite commissioning and start-up • Increase production capacity • Improve reproducibility of processes • Decrease process and quality variability • Improve long-term stability and consistency • Optimize paperless operation • Simplify configuration of continuous and batch control • Streamline application development and verification • Minimize downtime • Lower maintenance costs • Reduce lifecycle costs • Expedite payback on investments [6].

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