Control System Training

DCS Introduction

Agenda:

- DCS Introduction
  - PLC
  - SCADA
  - General architecture of DCS
  - Process or application
  - Scan time
  - Input and Output requirement
  - Redundancy
  - RTU and LCU
  - PLC vs DCS

DCS INTRODUCTION

PLC: Programmable Logic Controller

PLC is a controller device used for controlling a process or output depending upon the input status and the program logic downloaded into the controller. This device can also be called as Local Control Unit. The architecture of a LCU is as follows.

DCS INTRODUCTION

The LCU receives inputs from measuring devices and commands from operators and computes the control output needed to make the process follow the commands. It then sends the outputs to the actuators, drives, pumps, valves and other mechanical devices that regulate the process in field. The CPU does this process and it communicates with all the devices in LCU through the internal bus, which transmits addressing, data control and status information in addition to the data.

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SCADA: Supervisory Control And Data Acquisition

SCADA systems are used to collect data and control the processes at supervisory level. In SCADA the control could be for a process or even specific machinery, and the monitoring could be of any thing like an oil refinery, a power generation plant to a simple switch. The Data Acquisition could be collection of process data in terms of trends, alarms and events which could be referred to provide efficient control aid.

The PLC and SCADA combination were being used in most of the industries for automation, until the following factors became prominent ie the increase in size and complexity of the industrial process and technology development to maintain these processes. At this situation the DCS became popular because it could support the above requirement.

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DCS: Distributed Control System

Distributed Control System is a tightly integrated control system where in all the components used to communicate with the field process could be distributed around the plant.

The data from all these distributed systems are put together to control the entire process industries like the oil and gas refineries, the power generation plant etc..

The following architecture would explain it better.

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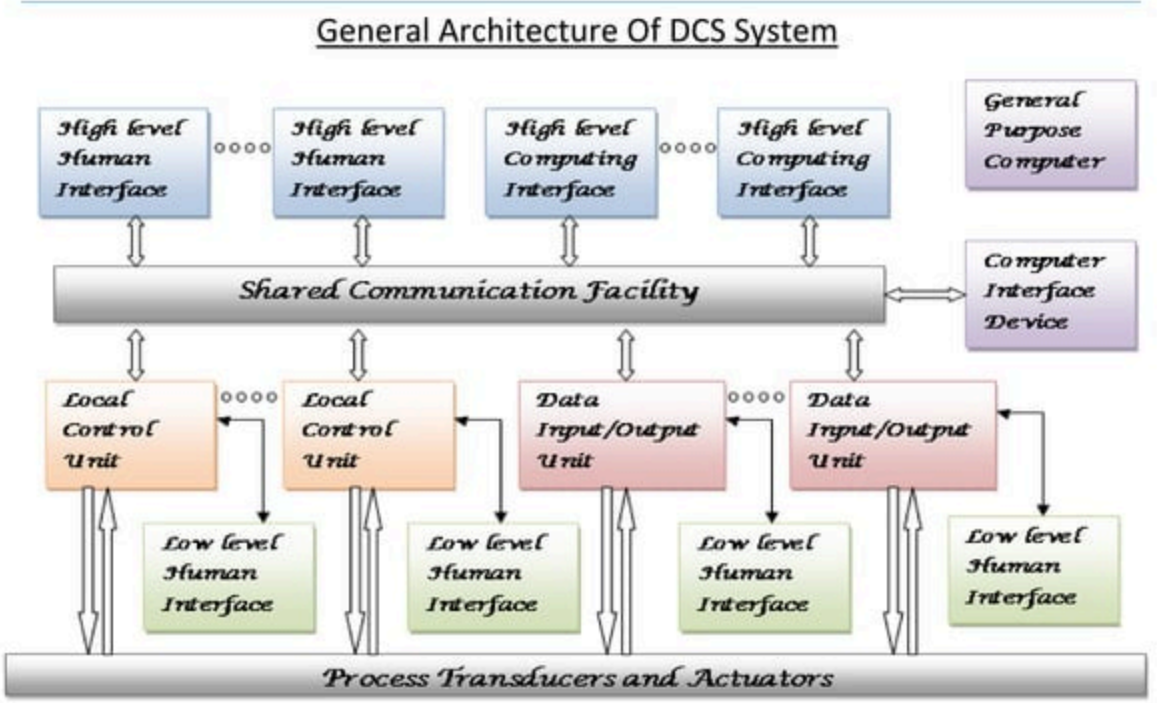

DCS INTRODUCTION

PLC Vs DCS THE CHOICE

When choosing PLC or DCS for a process or application the following criteria can be taken into consideration.

- THE PROCESS OR APPLICATION
- SCAN TIME
- INPUT AND OUTPUT REQUIREMENT
- REDUNDANCY
- RTU AND LCU

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THE PROCESS OR APPLICATION

In Factory Automation, the process would be of assembling or manufacturing specific items or things. In this process there would be lot of machines involved and the items would be moved among these machines to have the final thing. The products produced in these industries would be single product. The procedure would remain the same which would be repeated over and over again and such process is called as simple batch process. For batch process PLC is the choice.

In Process Automation industries the process involves transformation of raw materials through chemical reaction or introduction of physical changes to produce a new and different product. In this kind of process the current process always depends on the previous process or to say one or more process units are piped together, and such a process can be called complex batch process. For complex process DCS is the choice.

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SCAN TIME

- PLC is designed for high speed applications which require scan rate of 10ms or less. With this quick scan time the PLC can be used for control operations involving motion control, or control of motors and drives where high scan rates are essential for effective control of devices.

- When lot of regulatory analog loops are in the process like cascade loop, ratio loop and feed forward loop the response time doesn't have to be quick, it requires a scan time around 100 to 500ms range. In such regulatory process if the scan time is less then the final control element like valves could be damaged quickly. It is in such conditions where the DCS is used. While programming for the DCS device the scan time can be chosen.

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INPUT and OUTPUT REQUIREMENT

- In Factory automation process the type of inputs and outputs required are largely discrete, it also contains some analog control sequence to be implemented, in such conditions PLC is the choice as it can handle.

- In Process automation the operation involves transformation of product and this is done by controlling the analog parameters like level, pressure, temperature, flow etc and for such condition the DCS is the choice because it is designed to handle the large analog I/O requirement.

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REDUNDANCY

- This feature of the device comes into consideration based on the Downtime effect in industries. Downtime is the time period between process stop to the start of the same process.

- If the Downtime results in loss of production with additional cost and no damage to the process, and if the value of the value of the independent product is less then PLC is the choice. In such case the start up of the process is easier compared to process industries.

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REDUNDANCY

If the value of the products manufactured and raw materials used is high and if the Downtime will not only cause loss in production but also create potentially dangerous and damaging condition like for eg in some chemical applications the process has to be maintained at steady state or else the product could solidify in the pipe. In this condition DCS is the choice as it comes with optional redundancy choice.

- CPU redundancy
- I/O Module redundancy
- Communication line redundancy
- Server redundancy

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RTU AND LCU

RTU- Remote Terminal Unit: This device is used as the communication interface between the process and the controller. The RTU device would be at the remote location and would be containing the input output module, the process data would be received by these modules and sent to the controller through communication protocols.

LCU-Local Control Unit: This device is capable of performing closed loop control and also communicating with the master DCS controller when the data is required from the process controlled by the LCU unit.

DCS INTRODUCTION

PLC VS DCS

The following questions can be asked while choosing between a PLC and DCS.

1. What are you manufacturing, and how?
2. What is the value of the product being manufactured and the cost of downtime?
3. What do you view as the "heart" of the system?
4. What does the operator need to be successful?
5. What system performance is required?
6. What degree of customization is required?
7. What are your engineering expectations?

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1. What are you manufacturing, and how?

The way a product is manufactured, the performance needed, along with any physical limitations of the process, all influence the system selection.

PLC	DCS
❑ Manufacturing or assembly of specific items (aka "Things")	❑ Involves the combination and/or transformation of raw materials (aka "Stuff")
❑ Product is visible as it moves through the process	❑ Often impossible to visually see the product as it moves through the process
❑ High-speed logic control (such as motors)	❑ Regulatory/Analog (loop) control
❑ Simple Batch control	❑ Complex Batch Control

DCS INTRODUCTION

2. What is the value of the product being manufactured and the cost of downtime?

Downtime: The time between the stopping of process to restarting it again.

PLC	DCS
❑ Value of the individual component being manufactured is relatively low	❑ The value of a "batch" can be very high (either in raw material cost or market value)
❑ Downtime mainly results in lost production	❑ Downtime not only results in lost production, but can result in dangerous conditions
❑ Downtime does not typically damage the process equipment	❑ Downtime can result in process equipment damage (product hardens, etc.)
❑ Return to steady state production after an outage is short and relatively straightforward	❑ Return to steady state production after an unplanned outage can be long, expensive, and difficult

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3. What do you view as the "heart" of the system?

- In factory automation ,the control system is the controller (PLC), which contains all of the logic to move the product in through the assembly line. The HMI is often an on-machine panel or a PC-based station that provides the operator with supplemental or exception data.
- In process automation, where the environment can be volatile and dangerous, and where operators can't see the actual product, the HMI is considered by most to be the heart of the system. In this scenario, the HMI is a central control room console that provides the only complete "window" into the process, enabling the operator to monitor and control the processes which are occurring inside pipes and vessels located throughout the plant.

DCS INTRODUCTION

4. What does the operator need to be successful?

- In a PLC environment, the operator's primary role is to handle exceptions. Status information and exception alarming help keep the operator aware of what is happening in the process.
- The DCS plant requires an operator to make decisions and continuously interact with the process to keep it running. The operator's process knowledge is often critical to operational excellence and keeping the process running optimally.

PLC	DCS
❑ The operator's primary role is to handle exceptions	❑ The operator's interaction is typically required to keep the process in its target performance range
❑ Status information (On/Off, Run/Stop) is critical information for the operator	❑ Faceplates and analog trends are critical to "see" what is happening to the process
❑ Exception-based alarming is key information for the operator	❑ Alarm management is key to safe operation of the process and for responding effectively during plant upset conditions
❑ Manufacturing might be able to run "lights-out"	❑ Failure of the HMI could force the shutdown of the process

DCS INTRODUCTION

5. What system performance is required?

- The speed of logic execution is a key differentiator. The PLC has been designed to meet the demands of high-speed applications that require scan rates of 10 milliseconds or less, including operations involving motion control, high-speed interlocking, or control of motors and drives. Fast scan rates are necessary to be able to effectively control these devices.
- The DCS doesn't have to be that quick – most of the time. The regulatory control loops normally scan in the 100 to 500 millisecond range. In some cases, it could be detrimental to have control logic execute any faster – possibly causing excessive wear on final control elements such as valves, resulting in premature maintenance and process issues.

PLC	DCS
❑ Fast logic scan (approx. 10ms) is required to perform motor or motion control	❑ Control loops require deterministic scan execution at a speed of 100 to 500 ms
❑ Redundancy may not be cost justified	❑ System redundancy is often required
❑ System can be taken offline to make configuration changes	❑ Online configuration changes often required
❑ Analog Control: Simple PID only	❑ Analog Control: Simple to advanced PID control up to Advanced Process Control
❑ Diagnostics to tell you when something is broken	❑ Asset Management alerts you to what might break before it does

DCS INTRODUCTION

6. What degree of customization is required?

PLC	DCS
❑ High level programming languages are available for creating custom logic	❑ Custom logic created from existing function blocks
❑ Customized routines usually required	❑ Many algorithms (i.e. PID) are complex and do not vary among applications
❑ Standard libraries considered nice features	❑ Standard application libraries are expected (function blocks and faceplates)
❑ Provisions must be available to integrate functions/ products into an integrated architecture	❑ Entire system is expected to function as a complete solution

DCS INTRODUCTION

7. What are your engineering expectations?

PLC	DCS
❑ Program/configure individual components, integrate later (bottom-up)	❑ Up-front design of complete system before implementation begins (top-down)
❑ Desire customizable platforms to build upon	❑ Looking for significant "out-of-the-box" functionality
❑ System designed to be flexible	❑ System designed to make it "easy" to engineer process applications
❑ Solution is generic in nature, to be applied on a wide variety of applications	❑ Use of pre-defined, pre-tested functions saves time
❑ Use ladder logic to configure application	❑ Use function block diagram to configuration application

DCS INTRODUCTION

PLC VS DCS OVERVIEW

Characteristic	PLC	DCS
Market Introduction	1960s	1975
Replacement of . . .	Electromechanical Relays	Pneumatic & Single-Loop Controllers
Products Manufactured . . .	"Things"	"Stuff"
Classic Application	Automotive	Refining
Type of Control	Discrete	Regulatory
Redundancy	"Warm" Backup	"Hot" Backup
Engineering Mindset	"Programming"	"Configuration"
Operator Interaction	Exception Basis	Man in the Loop
Operator Interface	Simple Graphics	Sophisticated Graphics
Size/Footprint	Compact	Large
Up-front cost	$$	$$$$
System	"Open"	"Closed" (Proprietary)

Topics to be covered in the next session:

- DCS continuation

Thank you!