SIEMENS

DCS or PLC?

Seven questions to help you select the best solution.

The convergence of DCS and PLC technologies has made it more challenging than ever for process manufacturers to select the best technology for their application. A successful evaluation should start with developing a clear picture of the *requirements* of your application and the *needs* of your engineering, maintenance, and operations personnel.

Distributed Control Systems (DCS) or Programmable Logic Controllers (PLC)

Selecting the best automation technology is not as easy as it once was for manufacturers. In the past the differences between a DCS and a PLC were well defined. The advancement of the microprocessor resulted in a merging of the technologies. With the trend toward flexibility, many of the applications in the process industries share requirements traditionally thought to be exclusive to either DCS or PLC. These hybrid applications require a process control system that can deliver *both* DCS and PLC capabilities.

In this paper we will explore key questions to help select the system that best meets your goals. We will demonstrate why having a clear picture of the application requirements and the needs of your engineering, maintenance, and operations personnel is paramount to finding the right automation technology. Finally, we will provide you with a checklist to help determine your optimal system.

Benefits of selecting the "right" automation technology

In this era of global competition, manufacturers are being driven to achieve operational excellence to secure their place ahead of their competition. Consequently, the selection process is critical to a company's staying power. Selecting the right technology and supplier can greatly benefit your company by helping to:

- Respond quickly to changing market conditions to create a sustainable competitive advantage
- Minimize Total Cost of Ownership (TCO) of your plant
- Create a system that is maintainable and upgradeable
- Achieve the plant's and the system's future goals and vision

Let's get technical stereotypes out of the way!

Selecting an automation system based on a review of available products is the typical course of action. The challenge with this approach is perceptions of the systems that "make the cut" are based on stereotypes or by claims of the first salesperson in the door. Let's look at the components of a DCS or PLC-based system to see how different (or similar) they really are.

The below pictured system architectures look very similar. Both include field devices, input/output modules, controllers, a human machine interface (HMI), engineering, supervisory control and business integration.The differences only become apparent when you consider the make-up of the application.

In the DCS architecture diagram (Figure 1), redundancy is employed for I/O, controllers, networks, and HMI servers. Since redundancy adds cost and complexity, DCS users must carefully evaluate their need for redundancy to achieve required system availability and prevent unplanned downtime.

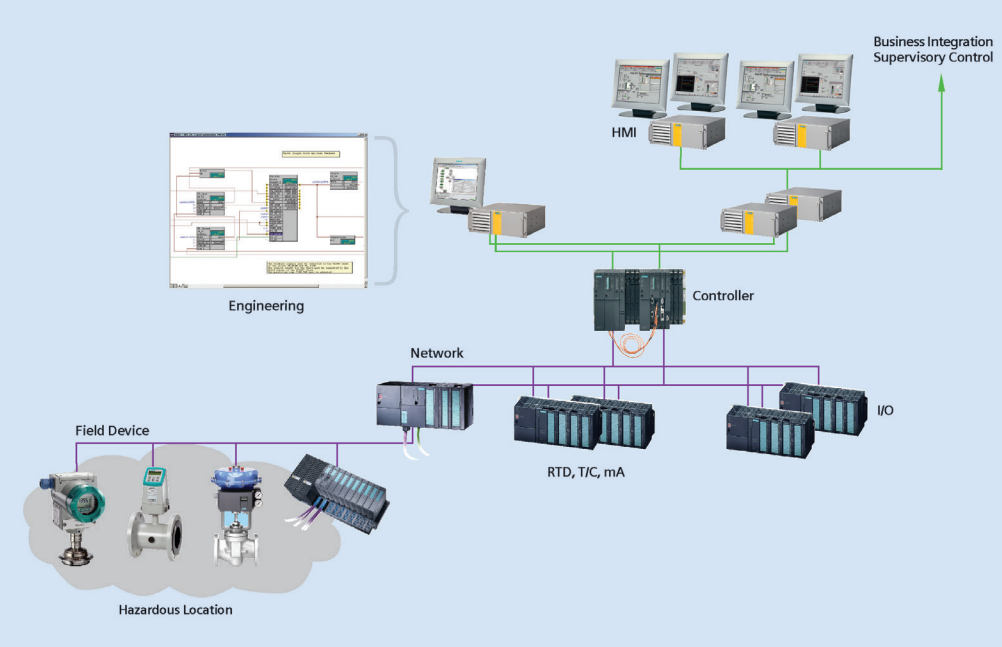

Figure 1
Typical DCS system architecture

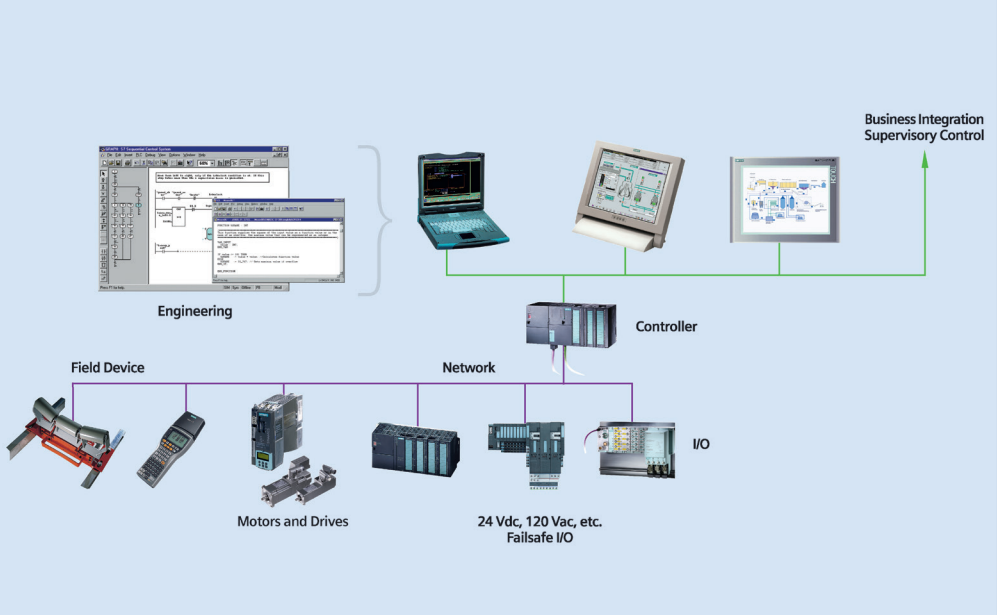

Figure 2
Typical PLC-based system architecture

The PLC architecture diagram (Figure 2) illustrates one of its most common applications, the control of discrete field devices. To effectively control motors and drives, requires that the controller be able to execute quickly (typically at a 10–20 msec scan rate), and that the technician responsible for maintaining it be able to read and adapt the configuration in a language that he is familiar with (relay ladder logic).

From a technology point of view, one can see DCSs and PLCs are not that different. We must look beyond technology to the application expertise that is built into these systems by the supplier, so that we can better understand the "sweetspots" where each is best applied.

The seven questions to ask yourself before choosing a system

Note we will be using broad generalizations in this analysis, and that every application will have exceptions; however, the logic is sound. Since Siemens works "on both sides of the DCS/PLC fence" delivering DCS and PLC solutions for over 25 years, we feel that we are in a position to tell both sides of the story.

These seven questions are designed to make you think about your company's operating philosophy and application requirements, taking into account the point of view of the stakeholders in your plant (engineering, operations, maintenance, etc.):

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?

A list of questions and responses are presented as a tearoff page at the end of this paper. One method for gauging whether you should be using a DCS or PLC is to review this survey form, checking all of the responses that apply.

1. What are you manufacturing and how?

Factory automation applications for the PLC involve the manufacturing and/or assembly of specific items – "things." These applications may employ one or more machines and a fair amount of material movement from machine to machine. A characteristic of this type of process is that the operator can monitor the "things" as they progress through the manufacturing line. The process is, by nature, very logic control intensive, often with high-speed requirements. This type of process is controlled by a PLC and Human Machine Interface (HMI) combination.

Process automation applications involve the transformation of raw materials through the reaction of components or the introduction of physical changes to produce a new, different product – "stuff." These applications may be composed of one or more process unit operations piped together. One characteristic is that the operator can't see the product. It is usually held within a vessel and may be hazardous in nature. There is usually a large amount of simple to complex analog control, although the response time is not that fast (100ms or greater). This type of process is often controlled by a DCS, although the analog control capability of a PLC may be adequate. A determining factor in the selection process is often the size of the control application (e.g. plantwide versus single unit and number of I/O points).

There may also be sequential (or batch) control needs. A PLC can be used effectively for "simple" batch applications, while a DCS is typically better suited for "complex" batch manufacturing facilities that require a high level of flexibility and recipe management. Again, the requirements of the batch application determine whether it is "simple" or "complex:"

• Number of products manufactured:	Single product	or	Multiple products
• Recipe parameters:	Constant	or	Variable
• Procedures:	Single procedure	or	Multiple (different) procedures
• Equipment utilization and arbitration:	Fixed/none	or	Flexible/often
• Frequency of changes to formulas and recipes:	Never	or	Often

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

If the value of each independent product being manufactured is low, and/or downtime results in lost production, but with little additional cost or damage to the process, the PLC is the best choice. If the value of a batch is high, either in raw material cost or market value, and downtime results in lost production and in dangerous and damaging conditions, the selection should be DCS. A plant that has a $10 million batch of a cancer drug in production that relies on strict and continuous temperature control, for example, has a lot at stake in the event of a glitch. The DCS system, which typically includes optional redundancy, is worth the additional investment for this type of application.

In contrast, a bottling operation that only needs to run 10 hours a day to meet production schedules, and which can be shut down for system maintenance, troubleshooting, or upgrades with little impact on the bottom line, is a classic PLC application.

In process applications running 24/7/365, downtime must be avoided at all costs, due both to lost revenue and to potential hazards. For example, a refinery has flares that are continuously burning off gas. The system controlling those flares simply can't fail, because if the gas isn't burning, it's collecting and pooling, causing an extremely dangerous situation. The more volatile the application, the more it may require a solution with lots of redundancy to ensure that the system is available when needed.

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

The heart of a factory automation control system is the controller (PLC), which contains the logic to move the product 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. Operational information resulting from data analysis is also a requirement for factory automation applications – driving demand for a more sophisticated HMI.

In process automation, where the environment can be volatile and where operators can't see the actual product, the HMI is considered 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 what is occurring inside pipes and vessels located throughout the plant.

4. What does the operator need to be successful?

In a PLC environment, the operator's role is to handle exceptions. Status information and exception alarming help keep the operator aware of what is happening in the process, which can run "lights out."

The DCS plant requires an operator to make decisions and continuously interact with the process to keep it running. Leveraging the operator's process knowledge is critical to operational excellence in keeping the process running optimally. Operators earn their keep during product grade changes and when adjusting the process to address changes in the production environment (such as a different feedstock). The operator will change setpoints, open/close valves, or make a manual addition to move a batch to the next stage of production. Within the HMI, faceplates and analog trends provide a view into what is happening in the production process, while the alarm management system focuses the operator's attention on areas where he must intervene to keep the process running within its target performance envelope. In the event of an HMI failure, the plant could be forced to shut down in order to keep people and equipment safe.

It boils down to the need to have an operator "in the loop" versus "out of the loop." The DCS operator is the ultimate system stakeholder, whose upfront buy-in for the HMI design is essential for overall project success.

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 does not have to be 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.

Taking the PLC system offline to make configuration and engineering changes may have less impact, since the platform is not running continuously or because the process can be restarted easily. In contrast, configuration changes and tweaks to the DCS system are done online, while the process is running virtually non-stop. Some process applications may only shut down once or twice a year for scheduled maintenance, while others, such as a blast furnace, are planned to stay on-line continuously for years.

The issue of analog control is important, but confusing. DCS was originally designed for delivering analog control, but to say the DCS has a lock on the analog control market reiterates the problem with traditional thinking. Increasingly, the PLC is capable of delivering simple-to-complex PID control, but the DCS is clearly the choice for applications with a large amount of advanced analog control, including cascade loops, model predictive control, ratio, and feedforward loops.

6. What degree of customization is required?

The expectation and desire to be able to create a customized application varies greatly between DCS and PLC users.

Because the PLC was originally designed to be a jack of all trades, the development of customized routines and functions is required to meet the unique needs of an application. A systems integrator may be applying a PLC toward a palletizing machine today and pointing it toward a laser cutting lathe tomorrow. The PLC delivers a "toolkit" of functions and elemental building blocks that can be custom-developed and chained together to address the requirements of an application. Provisions are available to enable the integration of functions and products into a seamless architecture.

Pre-engineered "solutions," consisting of standards, templates, and extensive libraries, are what DCS application engineers expect "out-of-the-box" when working with a new system. The highest priority of a DCS is to deliver reliability and availability, which often results in a design that trades unlimited functionality for repeatability and dependability. The significant tradeoff with the DCS is its inability to accept many custom modifications without creating compatibility issues. The system is expected to function as a complete solution, which drives the use of standard functions already built into the platform.

7. What are your engineering expectations?

Factory automation engineers want customizable control platforms that offer individual components that can be quickly programmed together to accomplish the task at hand. The tools provided by a PLC are typically optimized to support a "bottom-up" approach to engineering, which works well for smaller applications.

DCS engineers are typically most effective using a "top-down" approach, which forces them to put significant effort into the upfront design. This focus on upfront design is a key to minimizing costs, compressing the project schedule, and creating an application that can be maintained by plant personnel over the long term. Since DCS applications are typically larger in scope, the ability to propagate libraries and templates throughout the application is important to minimize rework.

The PLC is controlling a machine, while the DCS is controlling the plant. For example, a pencil manufacturer is producing an incredible amount of pencils at an extremely rapid speed using a PLC. By programming in machine code, engineers might be able to squeeze another 10 milliseconds out of the machine, which is now capable of punching out even more pencils and profits. The PLC engineer demands that kind of flexibility and open architecture.

The process engineers controlling entire plants with a DCS require more intuitive programming platforms, which utilize pre-defined and pre-tested functions to save time and drive repeatability.

Having the right tool for the job is also critical. Ladder logic is the ideal and preferred configuration language for many discrete control applications, such as high-speed interlocking or the control of motors and drives. Function block diagram, on the other hand, is preferred for continuous control and for implementation of alarming schemes.

Determining whether your application is hybrid

Now that we have reviewed the criteria for selection of a DCS or PLC, you may be thinking that your application requires capabilities from both. If this is TRUE, then you may need a process control system for hybrid applications.

A hybrid can be defined as follows:

- "The marriage of the discrete functions, which PLCs handled so simply and economically, with the sophisticated analog continuous control capabilities of the DCSs"*
- "Defined based on the industries in which the systems work and serve, like pharmaceutical, fine chemicals, food and beverage, and others"
- "The architectural marriage of the PLC simplicity and cost with the sophisticated operator displays, alarm management, and easy but sophisticated configuration capabilities of the DCS"

** Reference – Intech, Sept 2007, "Hybrid Control Identity Crisis: What's in a Name?"*

How to select a process control system for a hybrid application

This paper has described the key attributes and differentiators between classic DCS and PLC systems. This same information can be used to define the key requirements for a process control system that would be ideally suited for hybrid applications, such as those in the pharmaceutical, fine chemicals, and food & beverage industries:

- Controller – Can execute fast scan logic (10-20 msec), such as that required for motor control, and slow scan logic (100-500 msec), such as required for analog control, simultaneously in a single controller
- Engineering Configuration Languages – Provides ladder logic, function block diagram, and a powerful programming language for creation of custom logic from scratch
- Flexible Modular Redundancy – Offers the option of tailoring the level of system redundancy to deliver the required system availability by balancing up-front cost versus the cost of unplanned downtime
- Modular Batch from Simple to Complex – Provides modular batch capability to cost-effectively address the continuum of simple to complex batch applications
- Alarm Management – Offers powerful alarm management tools to help operators respond effectively to plant upset conditions
- System Diagnostics and Asset Management – Provides a rich set of built-in system diagnostics as well as asset management of all critical assets in the plant (transmitters, valve positioners, motors, drives, MCCs, heat exchangers, etc.)
- Scalable Platform – Hardware, software, and licensing supports smooth and economical scaleup from small all-in-one systems (10's of I/O) to large client/server systems (10,000's of I/O)

How to select a control system supplier for hybrid applications

The majority of today's well-known automation suppliers offer one technology or the other DCS or PLC. This is an important thing to realize when one is doing an evaluation for a hybrid application.

To make their offerings attractive to the hybrid industries, many suppliers are touting their capabilities to provide both DCS and PLC functionality in their system. As we have seen, the technology difference between DCS and PLC is quickly disappearing, leaving only the experience and domain expertise of the supplier as a key differentiator. However, gaps in domain expertise are not closed overnight; significant knowledge has been accumulated by suppliers over the last 30 years, so beware of suppliers who are just now claiming DCS or PLC capabilities in their portfolio. For hybrid applications, users who want to ensure that their requirements can be addressed should consider selecting a supplier who has a long and proven track record for delivering both PLC solutions and a "full-blown" DCS.

Conclusion

Many of the stereotypes are being replaced thanks to the convergence of PLC and DCS. This has opened up a new set of options for hybrid applications and for those process plants that traditionally used PLCs to control their electrical infrastructure (such as motors, drives, and Motor Control Centers (MCCs), while utilizing DCS for regulatory control. It's not about the technology. Most importantly, it is about the requirements of your application and what supplier has the best solution, experience, and breadth of knowledge to meet your needs.

Whatever you choose, we hope that you can feel like you have made a wiser and better informed decision based on the information in this paper. You may find that a traditional PLC or DCS no longer meets your requirements. If you have a hybrid application, then you may need a process control system which combines the best of the PLC and DCS, and a supplier who can provide a full offering of both discrete and process capabilities, all based on a common platform.

For more information email Amanda Thompson at: amanda.thompson@siemens.com

Project Name: _____

Select all responses that apply to your application.

1. What are you manufacturing and how?

☐ Manufacturing or assembly of specific items (AKA "Things") ☐ Can see the product moving through the process ☐ High-speed logic control (such as motors) ☐ Simple batch control	OR	☐ Involves the combination and/or transformation of raw materials (AKA "Stuff") ☐ Cannot see the product moving through the process ☐ Regulatory/analog (loop) control ☐ Complex batch control

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

☐ Value of the individual component being manufactured is relatively low ☐ Downtime mainly results in lost production ☐ Downtime does not typically damage the process equipment	OR	☐ The value of a "batch" can be very high (either in raw material cost or market value) ☐ Downtime not only results in lost production, but also in dangerous conditions ☐ Downtime can result in process equipment damage (product hardens, etc.)

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

☐ Typically, this is the controller	OR	☐ Typically, this is the HMI

4. What does the operator need to be successful?

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

5. What system performance is required?

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

6. What degree of customization is required?

☐ High-level programming languages are available for creating custom logic ☐ Customized routines usually required ☐ Standard libraries considered nice features ☐ Provisions must be available to integrate functions/ products into an integrated architecture	OR	☐ Custom logic created from existing function blocks ☐ Many algorithms (e.g. PID) are very complex and don't vary application to application ☐ Standard application libraries are expected (function blocks and faceplates) ☐ The entire system is expected to function as a complete solution

7. What are your engineering expectations?

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

PLC TOTAL _____ **DCS TOTAL** _____

Siemens Industry, Inc.
Process Industries and Drives
100 Technology Drive
Alpharetta, GA 30005
1-800-365-8766
info.us@siemens.com

www.usa.siemens.com/process

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