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# Control System Selection Key Criteria

## DCS, PLC, SCADA, and Future Technologies

WHITE PAPER

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- ✓ Understand strategic elements that promote long-term compatibility.
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- ✓ Identify capabilities with future architectures.
- ✓ Understand how a mix of DCS, SCADA, PLCs, ESD, SIS, and other technologies are often brought together to address control and monitoring across an enterprise.

# Part 1 Introduction

This paper sets out selection criteria for the types of systems that form the foundation of modern process automation: Distributed Control Systems (DCS) and Programmable Logic Controllers (PLCs). These two fundamentally different technologies are described in terms of the technical and business considerations that are necessary to make an informed decision.

Since the decision-making process, today, is much more than deciding between a DCS and PLC, we will also dive into other technologies, including safety instrumented systems (SIS), Supervisory Control and Data Acquisition (SCADA) systems and the emerging Internet of Things (IoT). In addition, new business drivers have changed the way we look at technology deployment. For instance, end users are addressing cyber security, merging IT and OT, emphasizing OPEX vs. CAPEX and focusing on sustainability of the system over the full lifecycle of their plant or process.

# Part 2 Selection Process

## KEY TAKEAWAYS

- ✓ Identify key factors that help drive down costs.
- ✓ Understand strategic elements that promote long-term compatibility.

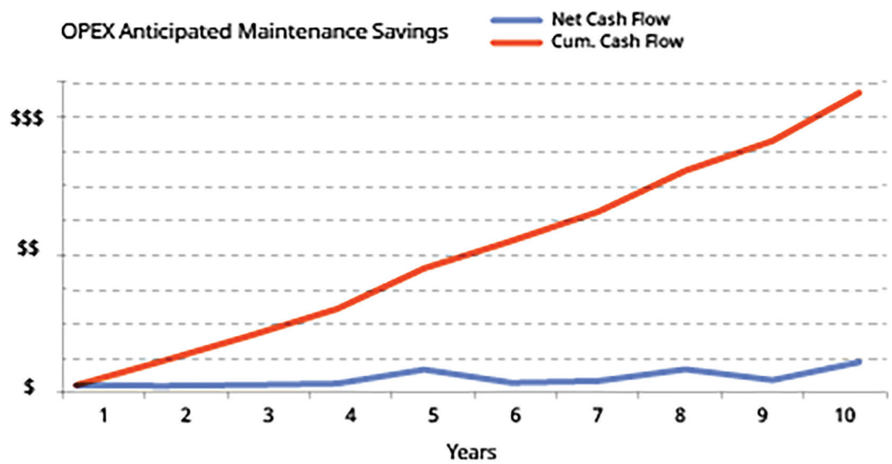
## BUSINESS CASE FOR NEW AUTOMATION INFRASTRUCTURE

The first decision about updating or replacing an existing control system is identifying the timing of technology improvements in large facilities. Starting a project too soon means that the maximum value has not been extracted and capital planning is inefficient, whereas modernizing too late often leads to excessive operational expenses. Generally speaking, modernizing the control infrastructure is best undertaken when the major systems can still be utilized, but the peripheral systems are out of regulatory compliance or do not support current technologies. However, a decision to replace the existing control system is sometimes catalyzed by a supplier dropping support for hardware and software, or system replacement parts becoming unavailable.

Complete migrations are conceptually straightforward financial decisions but may require extensive research and analysis to form a rigorous basis for a decision. As the various components of the control system age, operational costs in the form of repairs and replacements trend upward. Costly, unexpected shutdowns or equipment failures also increase in frequency. Degrading conditions reduce plant on-stream time, subject the facility to added maintenance, and may present safety risks. Together, degradations in control systems have effects that propagate through the plant, negatively impacting profitability, product quality, and safety. However, using this knowledge, managers can effectively model the cost of maintaining the old system versus migrating to a new system, plus associated plant turnaround time, and determine appropriate financial metrics such as NPV, ROI, and payback period.

> "...a comparative lifecycle cost analysis will help to determine not only the scope and timing of the project but the best control system supplier, as well.

Some control system suppliers have financial analysis tools that can help organize future CAPEX and OPEX cost; however, the sources of costs associated with maintaining versus replacing an aging control system are not difficult to model. A good financial analysis that enables sound decision-making for the control system modernization project will account for recurring, one-time (non-recurring), and irregular costs per period. The 'as-is' costs can then be compared to the same types of costs expected from a new control system for each supplier. The analysis should be done over the longest planning time horizon as practical, including the entire useful life of the new control system and, ideally, the entire life of the plant. Such a comparative lifecycle cost analysis will help to determine not only the scope and timing of the project but the best control system supplier, as well.



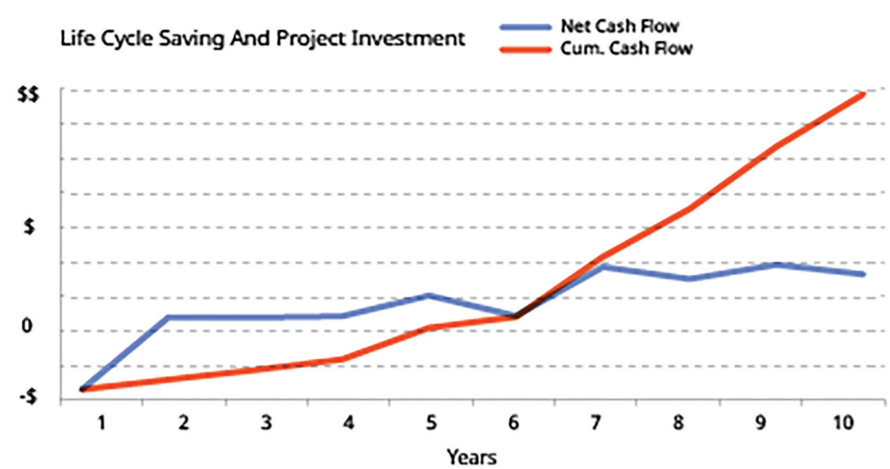




*Figure 1 – Example financial analysis comparing operating expenses, initial CAPEX, and savings between supplies*

## DECISION PROCESS – WHO SHOULD BE INCLUDED?

A comprehensive statistical study on the process for selecting a DCS (Hazenberg, 2009) described the various roles and business drivers that are involved in the decision process. Some nine years later, the process remains largely the same. The study identified two key buying values of decision-makers:

- Obtain the best control system solution for the price, not necessarily the most advanced, and
- Reduce equipment maintenance and related expenses.

The study referenced above also identified four key challenges to the selection process:

1. The exact criteria for selection are unknown;
2. The method for selection is often unknown;
3. There are multiple actors, each with their own biases and preferences for particular suppliers; and
4. Internal politics.

The control system will touch many groups beyond instrumentation, engineering, and procurement. Maintenance, asset management, energy management, electrical, operators, and others have a legitimate role in influencing the selection process. Management will guide the process, of course, to ensure that the control system that is selected will support safe, reliable, and profitable manufacturing processes.

The decision process should consider all the factors that drive down lifecycle costs, such as the long-term compatibility of sub-systems and their components.

However, if the overall objective of the stakeholders is reduced lifecycle costs at technical parity among prospective suppliers, not just the initial cost, the selection criteria can be clarified around this financial objective.

“*The decision process should consider all the factors that drive down lifecycle costs, such as the long-term compatibility of sub-systems and their components.*

**2 KEY BUYING VALUES OF DECISION-MAKERS**

Get the best control system solution for the price.

Minimize equipment maintenance & expenses.

## CONTROL SYSTEM STRATEGIC CONSIDERATIONS

- ✓ Ability to support changes
- ✓ Capacity to accommodate growth in the plant
- ✓ Long-term backwards compatibility

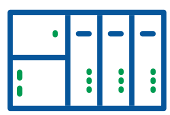
## STRATEGIC OUTLOOK FOR THE COMPANY

Another overarching consideration in the selection of a control system is the company's strategic outlook. Here, future changes in the manufacturing product mix to respond to dynamic market conditions would highlight the influence of business considerations on the process control systems. How easily will the selected control system, for instance, be able to support changes to the product slate, in the case of a refinery, or the introduction of new grades in a polymer train? How easily can the control system be upgraded in the future to accommodate growth in the plant? Will the existing system be backward compatible with the new components, say, five years out? These are some of the more strategic questions that need to be considered in the selection criteria.

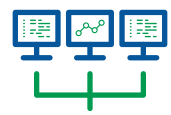
# Part 3 Key Process Automation Criteria


## THE BREADTH OF "CONTROL SYSTEMS"

Technically, a "control system" can be a single-loop controller or a distributed control system (DCS)--and anything in between. The most common reference to the control system in the process industries is Basic Process Control System (BPCS). Applying the term "manufacturing" in the broadest sense, there are two types of BPCS that can be employed:



**Programmable Logic Controller (PLC)**



**Distributed Control System (DCS)**

These two types of control systems were developed initially for distinctly different applications. Historically, the PLC was applied to control a large number of discrete I/O and programmed for specific tasks, such as discrete manufacturing lines and standalone pieces of equipment. The DCS developed from the need to control large continuous processes, such as refining and petrochemical operations. Continuous processes called for more sophisticated control schemes, such as cascade control loops, advanced (multivariate) process control, and process optimization, and the DCS became best-suited to support these technologies.

### KEY TAKEAWAYS

- ✓ Learn about the two types of basic process control systems.
- ✓ Know the criteria to consider when deciding to apply a PLC vs. a DCS.

Today, the differences between a PLC and DCS are less clear as suppliers of these systems have added capabilities to the PLC and greater scalability in the DCS. When to apply a PLC versus a DCS is driven by the manufacturing and business requirements; however, there are circumstances when a mix of system types is appropriate. Some of the example questions that inform this choice include:


**Product Value**
What is the value of a batch or the product stream over a shift?

**Process Startup / Shutdown**
How complex is the plant start-up and shut-down sequence?

**Instrumentation**
What is the relative mix of discrete & analog I/O?

**Control**
Do the control requirements include advanced regulatory control or just PID loops?

**Alarm Management**
Must the process adhere to ISA 18.2 or EEMUA 191?

**Safety**
Will the process require a Safety Instrumented System (SIS)?

Whatever the configuration and type, the BPCS is the “brain” of the plant, instrumentation its sensors, and devices that move the process, such as valves, actuators, and switches, its “hands”. This places the BPCS on the critical path of new plant construction since startup cannot occur without the BPCS and SIS being fully operational. The same is true in plant turnarounds, of course. Therefore, it is incumbent on those deciding on a new BPCS that consideration is given to how the selected BPCS will support the commissioning and startup process. This and other factors are described in the following section.

# Part 4 DCS vs. PLC: Factors to consider

## COMPLEXITY

While PLC-based systems are fine for basic PID control, a DCS will include advanced functions or function blocks that not only combine multiple PID controllers, as in a cascade configuration, but extend to entire process units. Advanced functionality could also include multivariable control and process optimization. To be fair to the PLC suppliers, numerous systems integrators have packaged many of these advanced functions in their own PLC application portfolios but, in the case of the DCS, they are provided by the manufacturer and included in release testing for version updates.

## RELIABILITY AND REDUNDANCY

The key architectural element of the DCS is the ability to distribute control of the process to individual nodes, which isolates segments of the process. Distributing control also increases system performance and reduces response times as each node is responsible for an area of the process. The DCS and PLC offer different approaches to redundancy.

DCS manufacturers typically offer fully redundant systems, including networking, power supplies, CPUs and I/O. The processors in the DCS provide “hot” switchover upon detection of a fault. This level of redundancy is more expensive, of course, but may be justified given the value of a batch or product stream. Most often, reliability is the primary consideration for selecting a DCS. A day’s loss for a refinery can easily cost over $1 million.

Good control design using PLCs will also distribute the control function among multiple PLCs in a large operation. One way increasing reliability in a PLC-based control system is to have a secondary or backup PLC run in “shadow mode.” Both the primary and secondary

PLCs receive the same inputs and share outputs. If a failure is detected in the primary PLC, the secondary PLC assumes control.

Reliability of the BPCS and SIS are key factors to consider when selecting a control system. A fair request of a prospective control system supplier is a written statement on reliability and redundancy. Can, for example, the vendor guarantee 99.99999% (“seven nines”) of uptime? And if so, what are the specifics of the system architecture that achieves this level of reliability?

## PROCESS CHANGE MANAGEMENT

Another important distinction between a DCS and PLC is in the software and system architecture that enable management of change in the controllers. Here, the scope of the control system will drive the decision to use a DCS versus a PLC, but closely related to scale is the ability to manage changes across the system.  A DCS uses a database that enables visibility and modifications of DCS components and control schemes across the plant. PLCs use application software to configure function blocks, sequence flow-charts, and structured, text-based instructions; however, programming is done separately on each PLC in the control system. There is no centralized database from which multiple PLCs are programmed, and change is managed.

## CYBER SECURITY

Depending on the industry and manufacturing process, security of the control system could be one of the most important factors affecting the decision on system supplier, regardless of the selected technology. The Stuxnet and Flame incidents are prime examples of vulnerabilities in a BPCS and the potential damages from a cyber attack. Weaknesses in security arose as standard computing architectures and operating systems (Microsoft Windows and Linux), Ethernet, and Internet Protocols (IP) were adopted by control system suppliers. While standards for operating systems and communication protocols enable greater compatibility between system components, the same standards pose challenges to securing a critical infrastructure system like the BPCS.

Security policies and practices for the BPCS and SIS are complex subjects, and their implementation differs for DCS, SCADA, and PLC-based control systems. Figure 2 depicts the different historical priorities held between general purpose IT systems and BPCS. Supervisory Control and Data Acquisition Systems (SCADA), Manufacturing Execution Systems (MES) and process Historians now bridge the BPCS and office IT systems, making cyber security of the BPCS as important as any factor when selecting the control system.

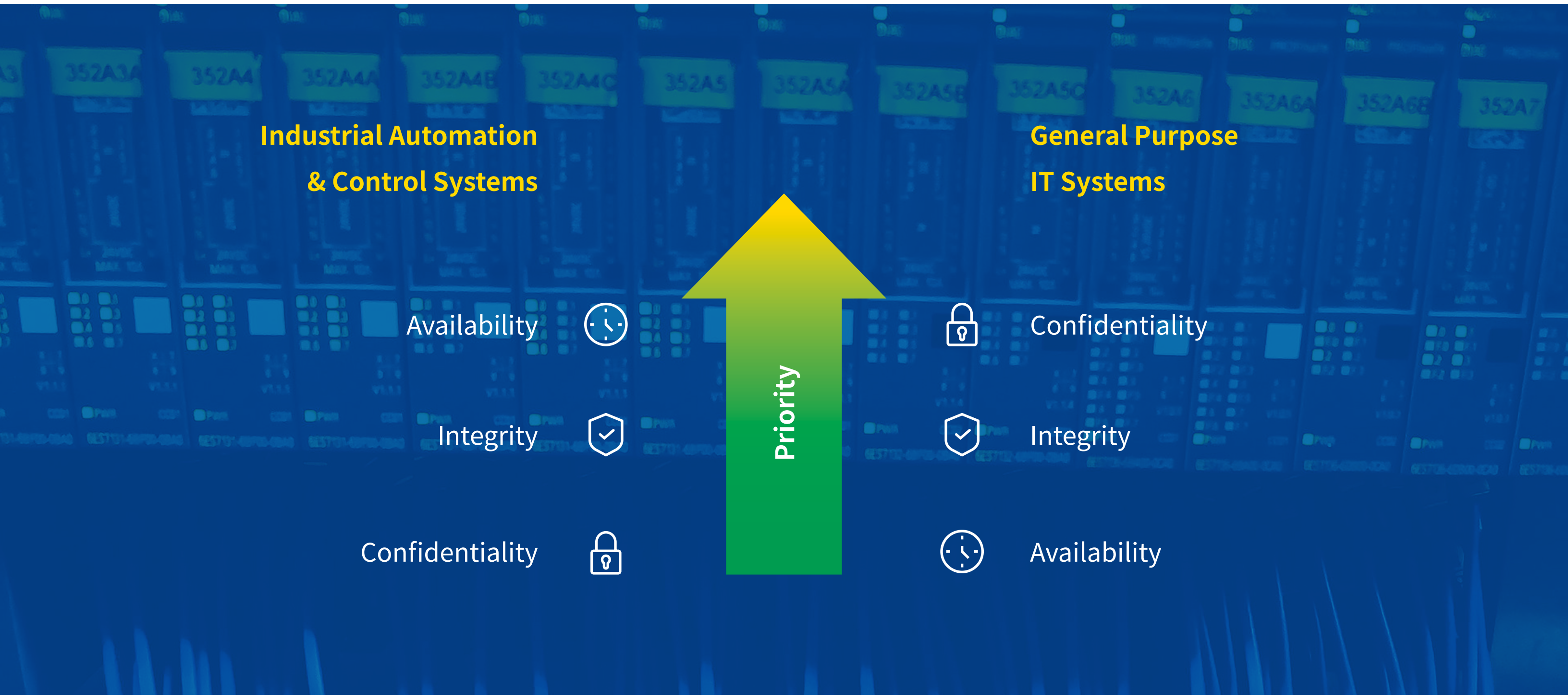



*Figure 2 — Differing roles of industrial control systems and general I.T. systems*

Some DCS suppliers use Microsoft Windows for the HMI but isolate the HMI and the control network via a secure gateway, and use a proprietary protocol for the control network. The operating system for process control nodes can also be proprietary, adding a layer of protection from a general cyber attack. The National Institute of Standards and Technology (NIST) has published a good source of recommended practices for Industrial Control Systems (Stouffer et al. May 2015) and the reader is referred to that document for guidance in cyber security for critical infrastructures, such as process control systems.

## SPEED / RESPONSE TIME

Historically, PLCs were employed to control equipment requiring fast response times, often less than ten milliseconds (ms). Today, the lines between PLCs and DCS have blurred here too as the DCS is now used to control processes and equipment requiring very fast responses, including turbomachinery. Fast response times of the control equipment will become increasingly important as some BPCS are required to control both the process and electrical equipment. The scope of the application of the BPCS can be a determinant if that includes both process automation and electrical management and control.

## SAFETY SYSTEM REQUIREMENTS

A Safety Instrumented System (SIS) is a specialized form of a process control system and is required by regulatory enforcement to be independent of the BPCS. However, unlike BPCS, the SIS is not actively involved in controlling a process but is dormant until needed. The classic example is a pressure relief valve that is jammed and does not open when the pressure exceeds a specified level. If no system is monitoring the state of the value, there is a risk to personnel and equipment. The role of the SIS is to monitor for such conditions and automatically interrupt or shut down the process safely when needed. Therefore, the SIS provides a high level of confidence that an effective and reliable response to unsafe conditions will always be executed when detected. This is not necessarily true of a BPCS.

While the decision for the BPCS architecture (DCS or PLC) and supplier are independent of the SIS, they should not be taken in complete isolation. Some history here will be helpful for context. In 1984, the International Society of Automation (ISA, formerly the Instrument Society of America), established Standards Project 84 (ISA84) to specify standards for Safety Instrumented Systems. During the late 1980s, the ISA brought together experts across industry and technical organizations including the American Petroleum Industry (API), National Fire Protection Association (NFPA), American Society of Mechanical Engineers (ASME), Institute of Electrical Engineers (IEEE),

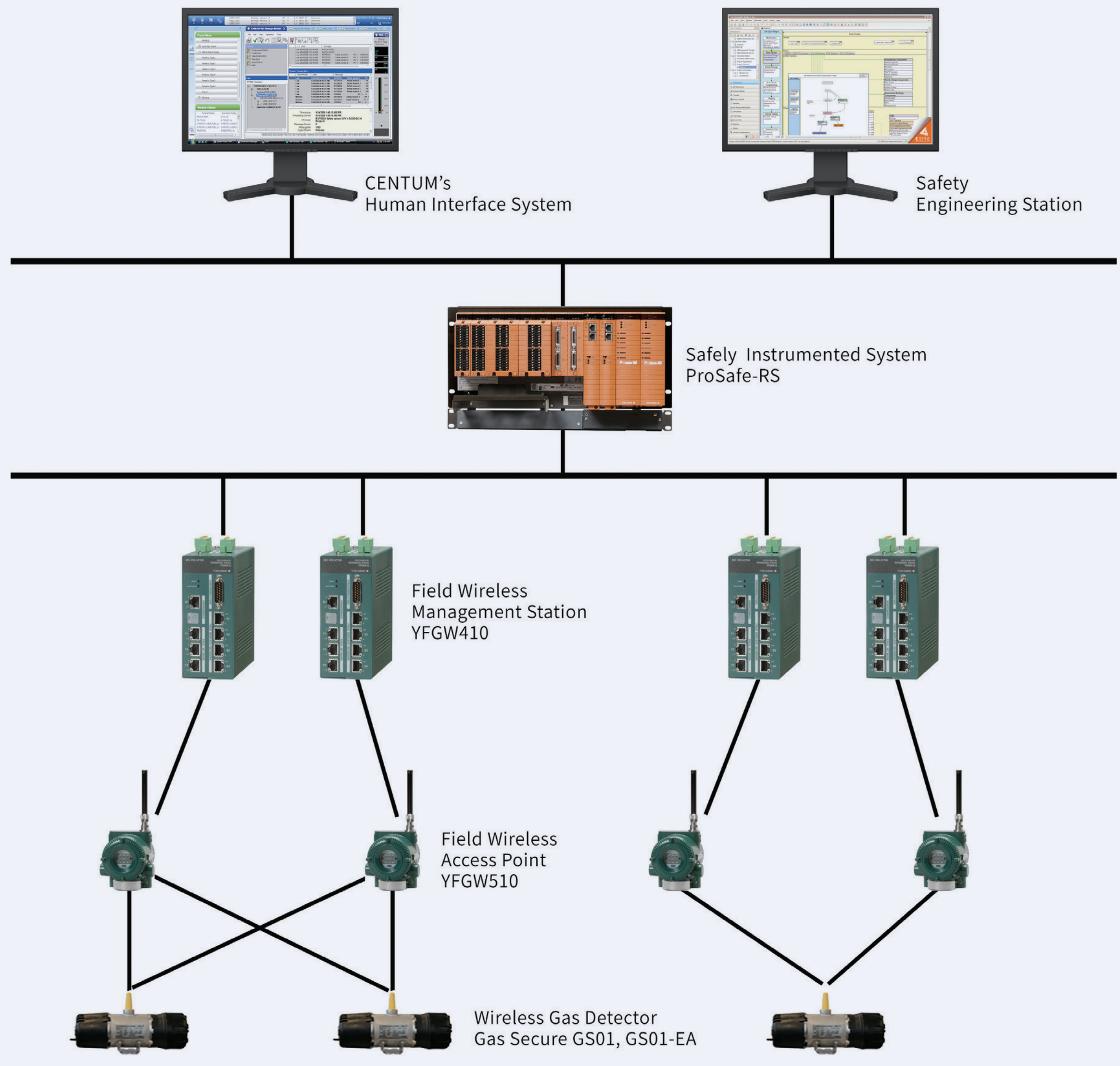
*Figure 3 — Key aspects to consider when selecting the automation technology and architecture*

Health and Safety Executive (HSE) of the U.K., and American Institute of Chemical Engineers (AIChE) to produce ISA84. In the late 1990s, ANSI/ISA-91.00.01 developed and approved a standard for "Identification of Emergency Shutdown Systems and Controls that are Critical to Maintaining Safety in Process Industries" (Johnson et al., 2012). Today, the scope of application of an SIS is determined by the specified Safety Integrity Level (SIL), criteria that are set out in IEC 61508 and IEC 61511.

| Key Capabilities | Comments | DCS | PLC | Equal |
|---|---|---|---|---|
| Analog vs. discrete I/O | What is the mix of analog vs. discrete I/O? A PLC is used to control mainly discrete I/O or to control a specific piece of equipment. A DCS is usually applied to continuous processes with large numbers of analog control loops and requiring more sophisticated control schemes. | ✓ | ✓ | |
| Reliability and redundancy | To what extent is redundancy required? Some DCS vendors offer multiple levels of redundancy while PLCs may be run in the "shadow" mode for redundancy. | ✓ | | |
| Change management | A DCS uses a database to manage information on loops and control schemes, where a PLC uses application software for programming but lacks a database where change can be managed across multiple PLCs. | ✓ | | |
| Cyber security | The DCS can provide Independence between Microsoft Windows and the DCS operating system (OS). This architecture is inherently more secure since a cyber attack must be customized to that vendor's OS to be effective. | ✓ | | |
| Speed / response | Depending on the application, a PLC is preferred if the response time must be in milliseconds (ms). This is often the case with rotating equipment and electrical power management. | | ✓ | |
| Control sophistication | PLCs are fine for simple PID control loops, but a DCS is needed for cascade controls, advanced process control, unit or plant-wide optimization, neural networks and other forms of sophisticated control schemes. | ✓ | | |
| SIS / HMI integration | The use of a Safety Instrumented Systems (SIS) is a critical system in a large plant, and has an independent operator interface with the same layout as that in the DCS for reduced training requirements. Having PLCs as the BPCS with an SIS is possible as well. | | | ✓ |
| Operator Training Simulator (OTS) | The OTS provides a digital twin of the plant by mirroring plant responses, but requires a supporting control architecture, typically in the form of a DCS. | ✓ | | |

In industrial settings, the BPCS (DCS or PLCs) and SIS are independent systems that communicate through a gateway; however, each system has its operator interface, event historian, asset management, and network communications. While complete independence between the SIS and BPCS is a regulatory requirement, some suppliers are now providing a consistent operator interface between the DCS and SIS. A consistent operator interface between the SIS and BPCS offers distinct advantages, such as reduced operator training with greater speed and reliability of operational responses in safety-related incidences. This topic will be referenced again in the comparisons between PLCs and DCS.

***Figure 4 -- Example Yokogawa Safety Instrumented System with HMI and Safety Engineering Station***



## OPERATOR SIMULATION / TRAINING

An Operator Training Simulator (OTS) provides a digital twin or mirror of the plant and can be applied across the complete lifecycle of an asset, from conceptual design through commissioning and on-going operations. Virtually the same system used for plant design and equipment sizing is employed to train operators and to enable real-time unit or plant-wide optimization. The OTS synchronizes with the plant control system and predicts plant internal states and responses. Given that over 90% of industrial accidents are attributed to human decisions, the value of an OTS is demonstrable. However, OTS is a high-fidelity model of the DCS, SIS, and HMI configurations, and therefore will require the supporting control architecture. Ideally, the decision to develop an OTS is taken in the early planning stages of a greenfield plant or plant upgrade so that its value can be realized in both CAPEX and OPEX reductions.

# Part 5 Mix Systems: DCS + SCADA + PLC+ HMI

There are many examples in which a plant will use a DCS for control and PLCs for assembly, packaging, and specialized equipment. Often, a PLC is included on an OEM skid. In these cases, the plant requires a mix of analog and discrete I/O, and likely uses advanced regulatory control schemes, while the assembly or packaging equipment uses mainly discrete I/O and straightforward sequence logic.

In the case of a process control upgrade where there may be an existing PLC, it is possible to replace the PLC I/O with DCS I/O and convert the PLC logic to DCS logic. This can be done in phases. A step-wise approach to such an upgrade can minimize downtime and avoid more complex testing and commissioning.

SCADA systems are industrial control systems that cater particularly to operations such as oil & gas production, natural gas gathering systems, pipelines and utilities, which are spread over broad geographical areas. A SCADA system can be comparable to a DCS in functionality and use multiple means of communicating with sensors and equipment.

Depending on the operation, a mix of DCS, PLC and SCADA could be the best control infrastructure. Midstream businesses with pipeline networks and gas plants across a 'supersystem' are good examples. Applications of control systems in a midstream operating company include (Payne, 2009):

- Field compression
- Gas conditioning (sweetening and dehydration)
- NGL extraction.
- NGL fractionation
- Heating systems

### KEY TAKEAWAYS

✓ Understand how a mix of DCS, SCADA, PLCs, ESD, SIS, and other technologies are often brought together to address control and monitoring across an enterprise.

However, some world-scale gas plants are of sufficient size to justify a DCS and use advanced control strategies. An excellent example of a broad mix of technologies is seen in a process automation project implemented by Shell Operating Company, the largest producer of gas in the Netherlands. The company maintains production in the Groningen gas field, plus onshore locations across the country and the North Sea. In 2009, production platforms across Shell used a mix of pneumatic controls, PLCs, and DCS of differing ages and brands. Shell selected the Yokogawa FAST/TOOLS SCADA software to integrate data from the platforms and enable system-wide monitoring and control from the central control room at Den Helder. Where an existing DCS could not be integrated due to its age, it was either upgraded or replaced with a Yokogawa Centum DCS. Indicating the scale of the project, the number of tags from DCS and SCADA increased from 200 to at least 100,000 for each location. Data historians were also used to make the data in the SCADA and DCS widely available at all locations.

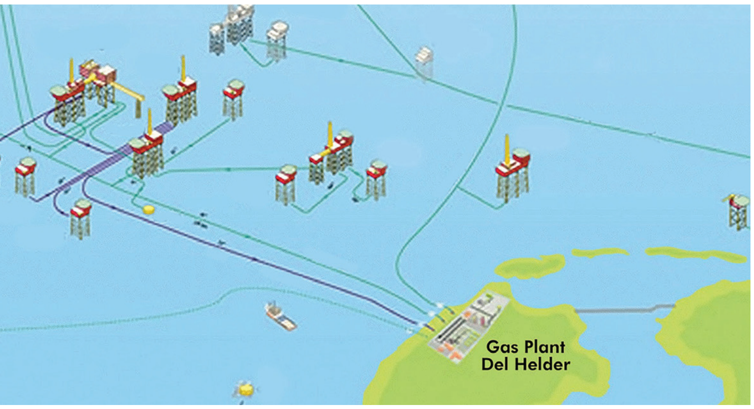



***Figure 5 – Platforms and gathering systems monitored and control from the central gas plant at Del Helder***

In another example of a mix of fit-for-purpose technologies, SembCorp Industries on Jurong Island in Singapore worked with Yokogawa to design and implement a total pipeline information and control system. The project included SCADA / PLCs, emergency shutdown (ESD), leak detection, billing, nomination and allocation, internet protocol (IP) telephony, video communications and network infrastructure. The fiscal management applications of the infrastructure required seamless integration and high reliability. The system also had to be expandable to accommodate the addition of end-users and gas suppliers, both through existing and new pipelines. Safety was also an overarching priority, supported by leak detection and ESD systems.

> “
> *A valid consideration of prospective control system providers is their ability to deliver a broad set of integrated technologies while assuring progressive compatibility with future software and hardware versions.*

These examples illustrate how a mix of DCS, SCADA, PLCs, ESD, SIS, and other technologies are often brought together to address control and monitoring across an enterprise. A valid consideration of prospective control system providers is their ability to deliver a broad set of integrated technologies while assuring progressive compatibility with future software and hardware versions.

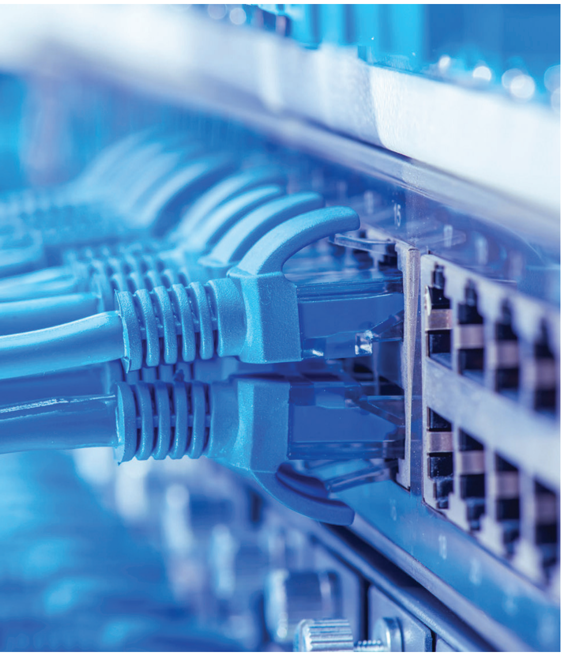
# Part 6 Future Architectures


## IIoT

The Industrial Internet of Things (IIoT) offers the tremendous promise of consolidating the traditional control hierarchy while applying large-scale, cloud-based computing to industrial processes. The early vision of integration from the “control room to the boardroom” is brought dramatically closer to reality with IIoT through the convergence of new technology and economies of scale. However, IIoT may deliver far more than the old vision of integration alone. The application of artificial intelligence (AI), machine learning and data analytics applied in near real-time using multi-node cluster computing, including graphical processing units (GPUs), has disruptive potential.

> “ *Using analytics in a cloud computing environment, AI and machine learning can be applied across an entire plant...*

Using analytics in a cloud computing environment, AI and machine learning can be applied across an entire plant for purposes including asset management, energy management, predictive maintenance, process optimization, and safety management. Data can be processed on a massive scale and presented in an optimal format for rapid decision-making by company personnel, anytime, anywhere.



Edge devices operate on a smaller scale by focusing on individual process units or remote locations such as oil wells. “Edge” refers to the physical location of the device nearby the process and at the edge of the network, which could be the DCS LAN, SCADA backhaul network or one that is completely independent. The term, “fog” is applied to Edge analytics in order to distinguish them from larger-scale, cloud analytics. Edge devices have already been put into practice optimizing production at gas wells and applying machine learning for turbomachinery predictive maintenance. Edge devices enable analytics applications even in situations where an existing network, such as in a SCADA system, lacks sufficient bandwidth for cloud computing. For security purposes, fog computing can also isolate the Edge from the Internet and can be used to protect intellectual property.

The confluence of these technologies will augment human decision-making, enabling more to be done with existing or even fewer staff. IIoT and cloud computing can be expected to complement the BPCS, MES, and supply chain systems of the future.

## ‘IT JUST HAPPENS’ INITIATIVE

In 2010 engineering at ExxonMobil Development Corp. launched an initiative to re-engineer the processes for major upstream capital projects (Montague, 2016). Branding the vision as “It Just Happens,” the scope of the process simplification work included the full plant lifecycle, from conceptual design through commissioning. This pioneering work, which was led by Sandy Vasser (now retired), catalyzed major changes among the way control system suppliers implement projects.

“

*One of the industry changes from It Just Happens was the emergence of the role of Main Automation Contractor.*

One of the industry changes from It Just Happens was the emergence of the role of Main Automation Contractor.

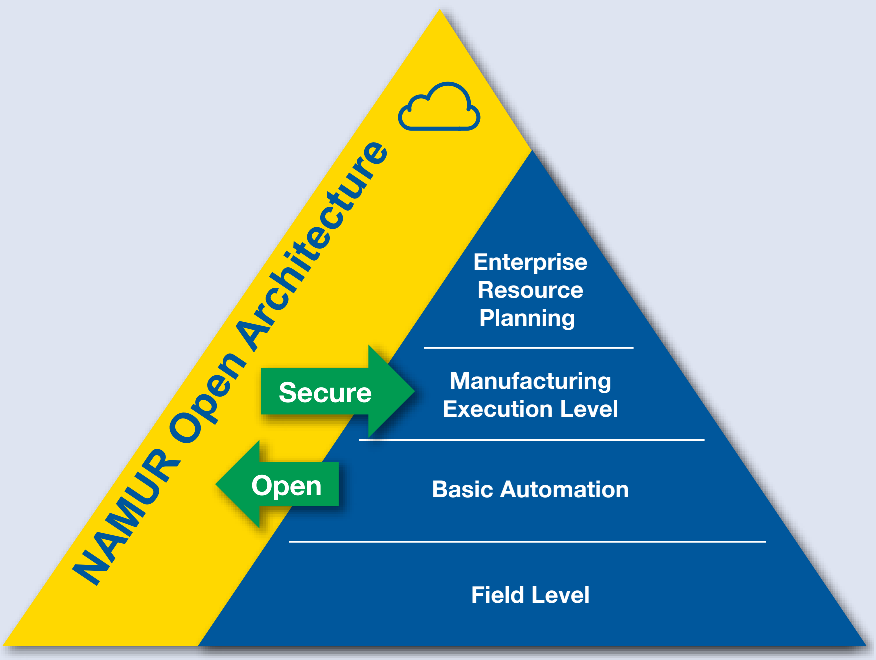
The (MAC) is a single entity responsible for engineering, procurement, control system hardware and software, and interfaces for components and systems. Depending on the scope of the control system or industrial automation project, a MAC may be a viable technical and commercial option. More on the role of the MAC is described on the next page.

## INDUSTRY INITIATIVES FOR OPEN SYSTEMS

In addition to the IIoT and "It Just Happens," two industry groups have open architecture initiatives underway. According to their website, the Open Group's "Open Process Automation Forum™ is focused on developing a standards-based, open, secure, interoperable process control architecture. The forum is a consensus-based group of end users, system integrators, suppliers, academia, and standards organizations. It addresses both technical and business issues for process automation."

The NAMUR Open Architecture, according to the ARC Advisory Group, defines "an automation pyramid, similar to the four levels of automation identified in the ISA-95 standard. In NAMUR's view, the automation layer is mainly concerned with critical aspects of operations, that is, real-time closed-loop control, and its interplay with instrumentation and actuation on one hand, and operations management and business applications on the other. NAMUR proposes to define a standard that both addresses the content exchanged, as well as a safe and secure protocol handling the communication" among the various layers.

***Figure 6 –*** NAMUR Open Architecture Automation Pyramid



# Part 7 Other Vendor Selection Criteria

Complementing the criteria for DCS vs. PLC, there are several other important considerations when deciding on the BPCS or SIS supplier. Four key considerations are described below.

## 1. HOW WELL DOES THE SUPPLIER'S STRATEGIC OUTLOOK ALIGN WITH THE COMPANY'S?

The owner's strategic outlook was addressed above, but how does the potential supplier's strategic outlook align with the company's? Investing in a major industrial automation project compares to taking on a business partner for operations - one that will have an impact on operations for ten years or more. Here, a few questions to consider of the prospective supplier include:

- What is the product development roadmap over the next five to ten years?
- Among current R&D initiatives, how likely are those to see commercialization?
- How do their development plans incorporate IIoT, data analytics, and the cloud?
- To what extent will they provide backward compatibility for new system components?

As referenced in Future Architectures above, the large technology companies are investing billions of dollars annually in cloud computing (SaaS and IaaS), data analytics, and machine learning capabilities. The cloud IT infrastructure is having a profound effect across all industries.

**KEY TAKEAWAYS**

- ✓ Understand the four key considerations when deciding on a BPCS or SIS supplier.

*"The cloud IT infrastructure is having a profound effect across all industries.*

Industrial automation will experience dramatic changes and understanding how the supplier intends to take advantage of these new technologies will be an important factor in the decision-making process.

## 2. HOW LIKELY IS THE SUPPLIER TO SUPPORT THE BUSINESS CASE?

This paper started by describing the tool of the business case in the decision process. (See Part 2 - Business Case for New Automation). The criteria provided herein can be used to assess each potential supplier, and one of those categories should be how likely the supplier may support the business case. Beyond the obvious considerations of one-time (CAPEX) and recurring (OPEX) cost of ownership, other factors include the supplier's ability to:

- Maintain an agile project execution methodology globally
- Design and implement the project on schedule, including commissioning
- Act as the Main Automation Contractor, if that contractual role is advantageous
- Minimize maintenance post-implementation through the useful life of the system

In general, rather than focusing on initial project costs, estimating lifecycle costs of the BPCS is a better basis for determining how likely the supplier will be in supporting the business case. The best project execution methodology will separate software applications and hardware I/O while enforcing procedures for change management (Beetsma and Schindler, 2015).

Using the Main Automation Contractor (MAC) empowers a single entity to coordinate among disciplines and suppliers, including all elements that comprise the BPCS, SIS, and OTS. Such a role consolidates responsibility and risk in a single supplier, so the vendor acting as the MAC must have a demonstrable track record for such projects. However, given that the MAC has charge of the whole automation infrastructure. efficiencies in project management and time-savings in commissioning can be realized. The EPC firm and owner-operator of the facility must have confidence in entrusting the supplier with the MAC role.

And, while a supplier's past success in delivering projects on-time and in-budget is not a guarantee of future performance, it is certainly an indicator. Therefore, a fair question to ask the prospective suppliers is the percent of past projects that are delivered on-time and in-budget for both brownfield and greenfield projects. Here, being on-time and in-budget for 90% of past brownfield projects and 99% of greenfield projects would be reasonable benchmarks indicating that the supplier would be most likely to support to the business case.

> "
> *... a supplier's past success in delivering projects on-time and in-budget is not a guarantee of future performance, it is certainly an indicator.*

## 3. TO WHAT DEGREE WILL THE VENDOR REDUCE THE TIME FOR COMMISSIONING?

Commissioning of the BPCS and SIS are on the critical path of plant start-up. Where effective project management and execution is the overarching theme impacting commissioning, there are important tools that work together to reduce the time for commissioning. Specifically, the effective supplier will apply modular process engineering software and use smart junction boxes.

The time required for commissioning is contingent on the effective and efficient design of the BPCS. NAMUR 148 has established "Automation Requirements relating to Modularization of Process Plants" (Version 22.10.2013) to reduce process engineering time by using modular software and hardware components. A valid discussion with the prospective supplier is about their agile project execution methodology and specifics of how they adhere to NAMUR 148. Specifically, to what extent does the supplier apply a library of reusable control programs based on ISA 88 or VGB-B 105?

One of the historical challenges to commissioning has been in the integration of field wiring, marshaling cabinets, and control system components. Fieldbus technology, including Foundation Fieldbus and Profibus, have offered the ability of configurable I/O systems. However, even Fieldbus systems don't allow devices to be mixed on a segment, and the data is bound to a given segment.

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*The best practice recommendation is to obtain from the supplier evidence of future compatibility and specify the level of support for upgrades and new versions in project specifications.*

The smart junction box was developed to address this limitation by automatically mapping individual device tags to the correct I/O address. Smart junction boxes eliminate the need to perform multiple tests of instruments to I/O addresses. Field wiring is terminated, and the smart junction boxes make the logical connection. In addition to greater flexibility, smart junction boxes minimize the time for testing and troubleshooting field wiring, shrink the cabinet footprint, eliminate cabling, and reduce cabinet design and engineering. There are differences between a DCS and PLC in the use of smart junction boxes, and this architectural difference must be understood at the outset when selecting between a DCS versus a PLC.

## 4. DOES THE SUPPLIER PROVIDE PROGRESSIVE COMPATIBILITY?

A key consideration in the lifecycle cost equation is the level of support for future upgrades. Some suppliers can guarantee compatibility for future versions of hardware and software, while others cannot.

The best practice recommendation is to obtain from the supplier evidence of future compatibility and specify the level of support for upgrades and new versions in project specifications.

# Part 8 Conclusion

Deciding on your next process automation system is much more than comparing DCS and PLC technologies. Not only must you tackle that aspect, you must also consider a hybrid between the two as well as other technologies such as SCADA and SIS.

Sustainability of not only the process automation system but also your plant operation over its entire lifecycle are now more important than ever. When you purchase a system, you have actually entered into a long-term partnership with the system supplier. Are your business models and long-term strategies aligned? How do the supplier's capabilities in terms of project execution affect CAPEX and OPEX? Are the supplier's capabilities as a Main Automation Contractor (MAC) important to your business?

> "*Sustainability of not only the process automation system but also your plant operation over its entire lifecycle are now more important than ever.*

In addition, which supplier could best support the system in a sustained manner over an extended lifetime? Also, which will best support new technology, such as the IIoT, and emerging, open architectures as proposed by ExxonMobil's "It Just Happens," the Open Group's Open Process Automation Forum and the NAMUR Open Architecture?

Strong consideration to these key factors will not only streamline the decision-making process but also minimize risks.

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