Cost Justification for DCS Migration

by Michael Rhodes

Executive summary

Distributed Control System (DCS) users are increasingly being faced with the dual dilemma of aging systems and increasing calls for productivity and quality. DCS migration can be considered complex and expensive, and difficult to measure in terms of ROI and payback periods. However, if businesses are to remain competitive in an age where new technologies can result in large productivity and economic gains, then migration must be considered a viable option for plants. This paper examines the reasons to migrate, the costs and benefits of migration, and what to look for when choosing a partner to perform the migration.

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Introduction

Industry experts estimate that there are nearly $65 Billion in automation systems in need of migration to current, more available technology. The challenge for users is developing the economic justification for making these significant investments. While many plants recognise the general growing need to migrate their systems, engineering teams struggle to capture the economic benefits of the required investments. There are many benefits associated with control system migration to be considered alongside the costs and issues. The main ones are discussed in this paper.

What is migration?

Distributed Control System (DCS) migration is defined as the replacement of old, often obsolete hardware and software systems with technically more current and readily available, higher performance control systems that preserve as much intellectual property as possible from the legacy system and minimise any impact on operations. Different vendors approach DCS migration quite differently.

Generally, there are four approaches to DCS migration:

1. **Full system replacement** – Many vendors require a complete system replacement from the I/O racks and cards to the processors and displays. Obviously, this can be quite costly as well as time-consuming and difficult to schedule as the time to remove, install and wire a new system can be extensive. This is also the highest risk approach to migration as the old system is not available in case of problems with the new system.
2. **Phased migration** – Other companies take a partial migration path where plants use their existing I/O systems and simply purchase gateways to interface with the new processors, HMI and software. This has the advantage of minimising the cost and time of replacing the I/O but does not address a common point of failure that will inevitably have to be replaced at some point.
3. **Cable solutions** – Some vendors attempt to minimise the expense of demolition and installation by using either wiring harnesses or I/O bus interfaces to tie new I/O systems to existing field wiring. While this approach preserves the installed I/O wiring, it adds a layer of complexity in I/O mapping and often requires additional panel space.
4. **I/O substitution** – A few vendors take the innovative approach of offering new I/O cards in the form factor of the existing I/O that simply plug into the plant's existing I/O racks, eliminating significant time and expense (see **Figure 1**). This allows a very quick change-over with virtually no impact to existing wiring and cabinets. This is also a very low risk approach as it is possible to test the entire system off-line and then tie in to the existing system by simply swapping the I/O cards. Further lowering the risk of this approach is the ease with which a retrofit can be temporarily reversed if problems are encountered during commissioning. This is the only approach that is easily reversible should operational pressures require a quick return to full production while problems are addressed off-line.

Figure 1
A Foxboro brand I/O card being inserted into a rack

Migrating a control system is much more than merely the replacement of the old with the new. Control system migration is also an opportunity for a plant to seriously consider a change in control system providers. At this time, the plant can use this event to evaluate the current and future offerings of major DCS suppliers and choose the platform which meets the quality, productivity and profitability needs of the plant both now and into the future. Plant engineers must think beyond traditional control paradigms and consider how new technologies and open platforms could positively impact their businesses in the coming years.

Why migrate?

Migration pressure comes from several sources. The most recognisable pressure is declining system reliability and the ensuing loss of production which can result as systems age. Often a plant reaches the point where its system must be updated to newer technology due to the high maintenance costs and excessive downtime that can occur with older systems. The availability of spare parts and expertise in aging systems are also major catalysts for a system upgrade.

However, there are other reasons a plant requires an upgrade which are not so readily apparent. First among these is lost opportunity cost due to the existing system's inability to respond to rapid, market driven changes in customer needs. Today's global economy demands smaller batch sizes and quicker change-overs which some older systems simply cannot handle efficiently. Another common issue that can drive a system upgrade is the inability to cost-effectively expand the system for increased production. Other problems that plants can often only address through system upgrades are lack of transparency, i.e. the inability to see enough process data in a timely fashion, and the need for the system to interface with more modern plant business systems in a real-time manner. This is becoming increasingly important as plants deal with variable costs such as energy which can vary greatly over the course of even one day. Some plants migrate one or more systems to achieve the benefits associated with having a single common platform. Finally, the aging workforce at many plants is raising the costly possibility of needing to train new employees on 20+ year old technology.

Financial benefits of DCS upgrade

What financial benefits can be expected from DCS migration? The first savings are in the reduction of unplanned downtime due to equipment failure. With downtime costing $100,000 per hour for some users, even small reductions in downtime can deliver significant cost savings. The second financial benefit is the reduction of hardware costs to replace system components. This can also be a significant expense as parts for systems nearing end-of-life can be quite costly. In addition, some plants are forced to use expensive third-party resources to make modifications to their older equipment due to lack of in-house expertise.

Additionally, direct financial benefits can be achieved by productivity improvements that come with reduced changeover times. Similar to the high costs of downtime, even small reductions in changeover time can generate big savings over the course of one year. Less easy to measure but still quite valuable are overall improvements in plant operation due to tighter integration with business systems. Finally there is the equally important factor of reduced “lost opportunity” costs due to ease in changeover, increased system flexibility and ease of expansion. All of these factors should be carefully considered when developing the economic justification for DCS migration.

Migration costs

The cost of implementing a new control system must be balanced with the cost savings and benefits mentioned previously. The costs of DCS migration can be broken down into five categories: equipment costs, demolition and installation costs, engineering costs, commissioning costs and finally the cost of the downtime required to perform the work. Following is a more detailed look at each of these costs.

Equipment costs are the most easily captured expense of a system upgrade, but can vary widely depending on the vendor and its approach to the upgrade. The complete new system approach favoured by many vendors is the most costly, as it includes the cost of the DCS itself plus new I/O cabinets and auxiliary electrical equipment. Other less extensive upgrades can save the cost of new cabinets and auxiliary equipment. The I/O substitution approach is the least costly approach as it uses all existing I/O cabinets, racks and auxiliary electrical control equipment.

Demolition and installation costs are generally the second most costly aspect of a system upgrade, behind the cost of system downtime. Depending on the approach to the migration, this expense can range from complete demolition of the old system and installation and wiring of the new system at a substantial expense to the simple replacement of I/O cards with virtually no demolition or installation costs. In between are several variations in scope such as using pre-assembled wiring harnesses to reduce the cost of rewiring I/O. In summary, demolition and installation can be very costly and there is tremendous variation in the offers provided by various DCS vendors. All plants should carefully analyse the different approaches available and fully understand the impact on demolition and installation expense.

The third area of major cost during DCS migration is engineering. There are three aspects to engineering. First is the physical design of new cabinets and new wiring diagrams. Second is the engineering and programming of the actual application. This second aspect presents a chance to work with the vendor to not only duplicate the system's existing software with all its idiosyncrasies, but to also optimise the performance of the new system by capitalising on new technologies and experience. When doing this, it is important that the upgrade provider have deep application knowledge and expertise in your specific industry and with your specific installation. The third area of engineering is the creation of new operator interface screens. Again, this is a chance to clean up any deficient areas and capitalise on the latest technologies.

System acceptance tests and commissioning costs are often overlooked when evaluating a DCS upgrade. Like most upgrade costs, these can range from the high commissioning expense of a complete new system to the relatively low cost of commissioning a system with I/O substitution cards. The latter approach allows a plant to be back online much more quickly as it uses the same wiring, which means the commissioning is limited to new application software and HMIs, both of which can be effectively tested and demonstrated during earlier factory acceptance testing phases. When evaluating test and commissioning expenses plants should work very closely with potential suppliers to understand the true expectations and duration of loop checking and system commissioning. It is also important to insist on a full factory acceptance test before shutdown for the system upgrade.

The costs and risks associated with the commissioning phase of DCS migration varies greatly depending on which migration approach is taken. Plants need to carefully evaluate the expense and risk of extended downtime and lost production should problems arise during this phase of the project and ensure that the chosen supplier has a contingency plan to minimise added expense should commissioning problems arise.

Choosing a vendor

This paper has referred to the importance of choosing the right vendor as being critical to the success of any DCS migration. The following section will expand on this important topic. There are four aspects to be considered (see **Figure 2**).

1. **Migration approach** – the first thing to carefully evaluate before choosing a migration system provider is their approach. As mentioned previously, the approaches of the main DCS providers range from the most common "out with old, in with the new" approach to relatively simple I/O card substitution in the form factor of the existing I/O racks. This decision will greatly impact total cost of ownership and potential justification of a new system. Choose a vendor with an approach that fits the needs of

the plant in terms of downtime and the urgency to implement the upgrade as soon as possible.

2. **Enterprise-wide integration capability** – the second thing to evaluate with the new DCS offering is the openness and ease of interfacing with existing and future plant, business and auxiliary systems. Closed, proprietary systems are a thing of the past so make sure the new system has the flexibility of standard communications and an open architecture in order to meet the need for enterprise-wide integration over the life of the system.

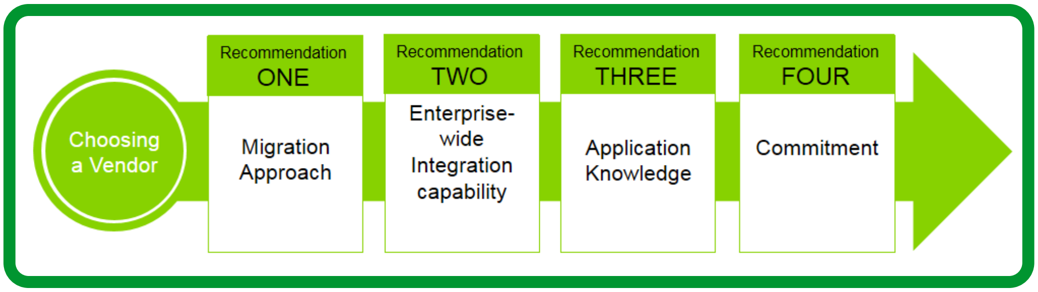

Figure 2
Recommendations when choosing a DCS migration vendor

3. **Application knowledge** – the third critical evaluation point is application knowledge. In order to maximise the investment it is important to work with people who understand both the business and applications. Make sure the chosen vendor has expertise and resources that know and understand both.
4. **Commitment** – finally, a DCS system is a long term investment. Accordingly, make sure to deal with a company who is committed to the long haul.

Calculating ROI

As an example, let's take a typical DCS system with 900 discrete I/O points, 600 analog I/O points and 150 control loops. The equipment cost ranges from approximately $275,000[1] to $325,000 depending on the choice of vendor and approach. System engineering may cost from $230,000 for an I/O substitution upgrade to $520,000 for a full system replacement. As a reference, ARC Advisory Group's research suggests as rule of thumb that $1,500 in engineering costs per page of graphics and three lines of code per hour are typical costs. Note that engineering is not only effected by the upgrade approach, but is also dependent on the quality of the conversion tools used by the chosen supplier, such as back documentation tools and advanced process graphics. It is also important to note that reusing existing field devices and I/O wiring has a significant effect on the engineering effort. The final major component of the upgrade cost is demolition and installation. These costs range from virtually no demolition or installation costs for I/O substitution migrations to as much as $230,000 for full system replacement (see **Figure 3**).

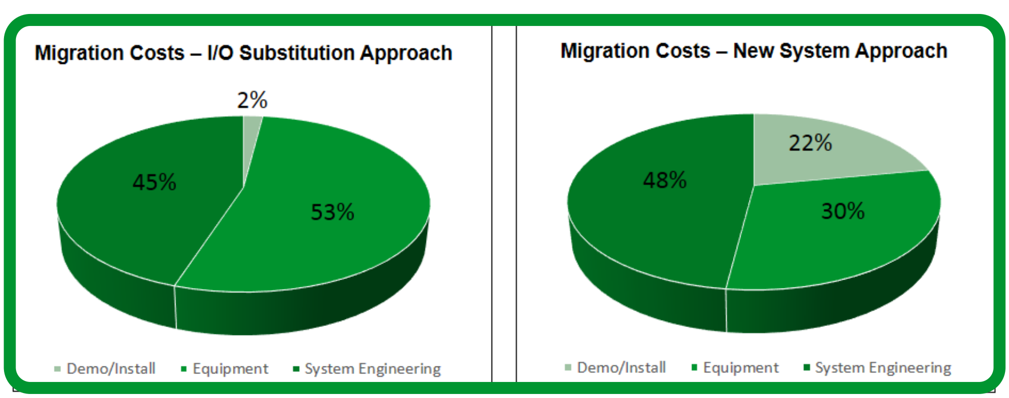

Figure 3
Differing costs for different DCS migration approaches

[1] All currency figures are in US dollars

To summarise, the cost of the example 1500 I/O point DCS upgrade can vary greatly depending on the approach the plant chooses – ranging from a low of approximately $510,000 for an I/O substitution upgrade to as much as $1,075,000 for a full system replacement.

In addition to the equipment, engineering and installation costs there are substantial costs associated with plant shutdown to perform an upgrade. In the case of a card substitution upgrade the required downtime is short enough that it can usually be completed during a regularly scheduled shutdown. Some plants have implemented this type of upgrade during a shutdown that is as short as 48 hours. At the other end of the spectrum a full system replacement requires a substantial shutdown of many days and even weeks. For that reason these upgrades are often implemented in phases. This means the investment justification is even more difficult since full system benefits are often not realised until the complete system has been upgraded. In some cases this requires scheduled shutdowns over a number of years. For the purposes of our calculations, we will use the downtime numbers of $500,000 for I/O substitutions and $3,500,000 for full system replacement.

Total cost for the example 1500 I/O system would range from around $1,000,000 to over $4,500,000 for a full system replacement. However, there are cost benefits which can be realised:

- Reduced downtime is the often the biggest benefit and also the easiest to measure. Downtime costs can be hard to estimate. They can be anywhere from $10,000 to $100,000 per hour depending on plant production rates and the value of the product being produced.

- Reduced maintenance expenses driven by fewer failures with the new equipment and the ability to generally service and maintain the system with in-house resources.

- Incremental productivity gains due to the power of more current technologies allowing more transparent data, faster change-over times and tighter interfacing with other plant systems. These gains need to be evaluated on a plant-by-plant basis taking into account the operating practices of the plant and the capabilities of the new system.

- Increased flexibility is another cost saving as it allows plants to move into new production activities with less cost than would be otherwise expended.

"With the lower cost I/O substitution method, the return on investment could be 344% with a payback period of only 3.5 months."

Continuing the example, assuming a downtime cost of $50,000 per hour and a reduction in downtime from 1% to 0.5% - the savings from that small improvement in downtime alone would equate to $2,190,000 per year. Add to that reduced maintenance expenses of $150,000, and the example shows that small productivity gains can result in huge savings. In addition, assuming a productivity improvement of 0.25%, an additional $1,095,000 in annual savings can be made. As this example shows even nominal reductions in downtime and improvements in productivity can mean big financial gains for a plant.

With financial gains after migration equating to $3,435,000, the return on investment and payback period can be calculated. Return on investment (ROI) is calculated by dividing the total financial gain, or return, over a given period of time by the total cost, or investment, over the same period of time.

With the lower cost I/O substitution approach the cost of the migration is $1,000,000 which means the ROI would be $3,435,000/1,000,000 or 344% over a one year period. This would be considered a very healthy return. The payback period is the time, generally in months, it would take to pay back the initial investment. For this example that would be $1,000,000/ $3,435,000 X 12 months per year = 3.5 months, which is an exceptional payback period.

The same calculations can be made for the more expensive approach of a complete new system. The benefits would be the same at $3,435,000 per year but the cost would be substantially higher at $4,500,000. The return on investment would be $3,435,000/$4,500,000 or 76%. The payback period would be $4,500,000/$3,435,000 X 12 months per year = 15.7 months.

Conclusion

DCS migrations are becoming increasingly necessary as large amounts of installed equipment reach obsolescence. This presents an interesting opportunity for plants to re-evaluate vendors and technology and make the best choice for their specific plant based on factors such as transparency, open architectures, ease of system expansion and cost and ease of implementation. Complicating the process is the broad spectrum of migration approaches supported by the major DCS providers, with an accordingly broad range of associated costs.

Plants need to carefully evaluate the offerings of the major DCS providers and make sure they choose a supplier which meets their short and long-term technology, business and profitability needs. At the same time they need to also choose a migration approach which meets the needs of the plant in terms of financial justification and impact on operations. DCS migrations can generate very strong returns on investment and very short payback periods when low cost migration approaches are combined with highly functional and flexible control platforms. With a thorough evaluation and careful selection, plants have the ability to position themselves for long-term profitable operation with the next generation of DCS controls.

About the author

Michael Rhodes is Schneider Electric’s Global Practice Director, Process Automation, Industry Business. With more than 20 years experience in the automation industry, he is responsible for developing forward-looking products and services that extend the life of installed process control and safety systems. Prior to Schneider Electric, Michael held management positions in engineering, services and sales with other industrial automation suppliers including ABB, Measurex and Kawasaki Robotics.