

Some Factors to Consider When Selecting a Monitoring and Control Platform

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This white paper will be of interest to anyone who is involved in or has an interest in selecting a product for monitoring and controlling equipment. In particular, process control engineers, utility SCADA engineers, building managers, research and development staff and academic staff involved in research projects will find the information presented here to be useful in assessing and selecting a monitoring and control platform.

Introduction

As the heart of many a process control solution, selecting the right monitoring and control platform is pivotal to ensuring the success of the solution and certainly merits sufficient research to make an informed decision. Although monitoring and control systems can be selected based solely on budget and matching features to requirements, this approach does not consider the total cost of deploying the system to the field.

As anyone who has been through the process of developing a proof of concept and deploying to the field can testify to, there is substantial effort required to conceive a solution and carry it through various growth stages where it can be confidently used for full-scale deployment. Selecting the right monitoring and control system can significantly ease this burden by providing the features and capability to facilitate that process.

This paper presents a number of commonly overlooked factors to consider when selecting a monitoring and control system for proof of concept, pilot projects, industrial or academic research projects or other projects requiring the continuous collection of data from sensing devices and analysis of that data. Careful consideration of these factors will assist in selecting the right system that will reduce engineering churn when developing and growing the solution as well as keeping the ongoing operational and maintenance costs to a minimum.

Discussion

Monitoring and control (M&C) solutions abound, so how do you select a product that meets your requirements and is fit for purpose? In this context, fit for purpose means that it reliably provides the required functionality under all anticipated operating conditions and ideally, many of the unanticipated ones as well.

Determining whether an M&C product meets your requirements implies knowing your requirements. Most buyers are prepared with a checklist of features they need or want and use this as the basis for comparing products from different vendors. This list typically focuses on the immediate hardware and engineering aspects of the system as these normally represent the more obvious largest portion of the costs.

Although these criteria are vital, they need to be balanced with factors that have a direct impact on the total cost of ownership – factors that are often overlooked until the system has been deployed in the field and their impact is being felt. These factors contribute to the total cost of an M&C system.

Total Cost of Ownership

Total Cost of ownership can be loosely defined as the sum of the one-time capital (hardware, software) and engineering costs as well as the recurring operation and maintenance costs. Some initial capital investment and engineering costs include the following:

- Software license fees
- Equipment purchases
- Engineering and system integration effort
- Facilities to setup and test the entire system
- Factory testing prior to deployment
- Field communication (radio, wiring) hardware and setup
- Network equipment, software and setup
- On site testing
- Site commissioning

Operation costs will vary widely depending on the type of system, number of systems deployed and many other factors. Below we list some of the more common sources of operation costs. Note that these costs are per deployed system:

- Annual support fees
- Training engineering staff to use the tool
- Training operators and other users to use the tool
- Fine-tuning system parameters
- Adding or removing devices
- Converting data for further analysis
- System license upgrade
- Upgrade of related third party software
- Upgrade of computer and communication hardware
- Configuration and test effort for each upgrade cycle
- Engineering effort to install and commission upgrades

Newer platforms tend to place more emphasis on ease of use, an area where many legacy systems struggle. Older systems can suffer from software bloat which often results in unnecessary complexity, innovation stagnation and heavy support costs.

Worth noting is the correlation between complexity and cost. Systems that are more complex to configure and operate will result in much higher training costs, development costs and testing costs. As well, complexity does not imply flexibility. Complexity can be a result of negative factors such as ill-conceived software architecture, aging technology, a user interface or tools that do not support the work flow, or mismatched system components.

What are the Requirements?

Unlike a typical software product, an M&C system cannot be specified as a simple set of required functions and features. Every M&C system will have a group of users and perhaps the biggest challenge in defining the requirements for that system is understanding the end user requirements – those requirements that are related to how operation staff would like to use the system. Compounding this difficulty is the unavoidable tenet that each group of users has its own unique way of interacting with the system. Multiple end user groups can then translate into multiple, often conflicting sets of requirements.

End users may come from the following groups:

- Operators/Maintenance staff
- Supervisors
- Planning engineers
- Protection engineers
- Production engineers
- System Integration support staff
- Accounting
- Corporate Managers

In addition to the above, it is sometimes necessary to look beyond the users in your own organization to external users such as partners who share ownership of the facilities/data or regulatory bodies at the local, regional or national levels. These relationships are often evidenced by the need to present data to multiple master stations.

As is the norm for user interfaces, getting a clear definition of the users' requirements will involve development of several prototypes or a pilot project to give users the opportunity to interact with the system to refine the presentation and functionality. This does not mean you should not attempt to capture operational requirements prior to purchasing a system, it simply means that you should count on modifying the user interface after the system is in use. These refinements are best done prior to full field deployment while you have more latitude to make the changes without affecting a live field system.

Another pitfall when capturing requirements is that in many cases, requirements are derived from users' previous experience with M&C products. This tends to limit solutions to "what is" rather than "what can be" and requires some effort to separate the true requirement from the solution. Other requirements creep into a specification because they are part of the feature list

of an existing product. This sort of “begging the solution” scenario occurs when someone has already decided they want a particular product and the system specification is written to accommodate the feature set of that product.

When you have collected your requirements from various sources, you will need to distil them into a comprehensive list. Distilling the list of requirements will involve separating needs from wants, combining similar requirements, resolving conflicts, classifying, prioritizing and eliminating. Perhaps one of the most challenging tasks is resolving conflicting requirements that originate with different user groups.

Features to Look For

Although many M&C systems share basic functionalities, there are certain features that can make a fundamental difference in how a system can be used and the resulting total cost of ownership. The following sections identify and discuss a few key features.

User Interface

The Human Machine Interface (HMI) is a key component of an M&C system but typically represents only about 20% of the overall system functionality. As the focal point of many end user requirements, the HMI tends to attract a lot of attention and generate controversy especially when conflicting requirements exist.

HMIs for M&C systems must be programmable so that the custom displays specific to the system can be built. However, the level of programmability, ease of programmability (i.e. tools) and level of sophistication varies widely. Depending on how involved the end user requirements are, the HMI programmability may have to be examined closely to ensure that the requirements can be met. Not surprisingly, the two extremes for the functionality/cost equation are:

1. Limited capability and programmability with low cost
2. Sophisticated feature set and high programmability with high cost

If your HMI needs are fairly simple, a less capable HMI may be adequate. However, as the complexity of your needs grows, the engineering effort required to transform that less capable HMI into an acceptable solution escalates very quickly. The cost of this engineering effort can easily outpace the incremental cost of a more capable HMI that would require less engineering effort and likely produce a better solution.

In addition to the typical animation driven by real-time data and basic user interaction features, the following are items to consider when looking at HMI capability:

- Ability to generate comprehensive displays that go well beyond displaying basic animated objects
- Ability to zoom in and out with decluttering
- Ability to programmatically drive a single screen with data from a database
- Integrated user-specific security

- Ability to view the same screens through a dedicated viewer or a web browser. Note that web displays should not rely solely on ActiveX components or Java applets as many corporate firewalls block both of these for security reasons.

Scalability

Many pilot projects begin life as a small endeavour which then grows in size to accommodate additional requirements as the project gains management visibility or achieves a certain level of success. This places a strain on the budget and the tools, as a well-designed pilot project is intentionally constrained in requirements and scope to control the project costs.

Typically, either the facilities or the number of facilities to monitor grows in size over time. A well designed and fully functional system for one or a few facilities works fine. The majority of the existing M&C solutions have a limit on the number of points or facilities that they can monitor. This can result in a complete overhaul of your entire system when it reaches certain size.

Accommodating additional requirements can be tricky business if the solution tools were selected to satisfy a much more constrained list of requirements. Choosing an M&C platform that is scalable enough to accommodate growth in the number of data points monitored provides some insurance against unplanned or unanticipated growth. However, for maximum effectiveness that database scalability must be matched with a configuration system capable of handling that growth without requiring an equally large amount of effort.

Programmability

Due to their ability to monitor field signals and control outputs through logic, programmable logic controllers (PLCs) and Remote Terminal Units (RTUs) are a popular choice for adding various forms of automated response without having to purchase a specialized tool. However, from a human interface perspective, PLCs and RTUs can be difficult to use and require significant man-hour investments to develop large and complex control algorithms. PLCs also provide limited visibility into program execution, which hampers your ability to troubleshoot a misbehaving program. RTUs have the advantage of allowing the user to develop custom applications but are more complex to configure and maintain.

If you do not need a PLC for managing a time-critical process, consider using an M&C platform that provides a general purpose automation tool. Such a tool typically offers a much friendlier user interface and provides significantly enhanced capability to monitor and troubleshoot your automation program.

A general purpose automation tool also enables further opportunities for data processing and manipulation that extend well beyond the limitations of the PLC environment. Such a tool also provides opportunities for adding automated response and processing capability to areas that might otherwise be addressed through manual effort. This is a very tangible benefit that often proves its worth when an unforeseen need materializes during the transitioning of your solution from the lab to a pilot project or the field.

Application Development

There are instances where the best solution to problem is a custom application that does exactly what you want it to and nothing more. This is certainly a consideration when the alternative is large and unwieldy automation program that may be difficult to maintain or configure.

A custom application may also be the only alternative if the M&C system of choice does not support some obscure protocol or proprietary device interface essential to your system. Another benefit of using a custom application is that intellectual property can be somewhat protected as compiled code rather than exposed through an automation program.

If you have highly specialized requirements or need to protect your IP, developing your own application may be the best solution. Look for an M&C system that provides an application programming interface (API) providing access to all essential system features and allows you to integrate your application seamlessly. Ability to develop that application using commonly available development tools and technologies would be a huge bonus.

A well developed M&C system should provide a Software development kit (SDK) package that allows you to develop your own custom applications independently.

Historical Recording

Effective Historical Recording for an M&C system must be able to log large amounts of data very quickly. The requirement for this recording can be separated into three categories:

1. Slow periodic recording for basic and conventional reporting
2. Fast periodic recording for the purpose of real-time trending and analysis
3. Log all system changes for the purpose of Audit Trail, SOE and various analysis or advanced reporting purposes

Typical M&C system handles the first two categories easily by utilizing any one of the standard relational databases such as SQL, Access, Oracle or other similar packages; however, the majority of M&C systems fail to address the last category. All data in this category must be generated and logged in the form of events (not scanned); otherwise there is no guarantee that the historian will capture all events between each scan.

A good historical recording system will allow you to record any data required for a thorough post-mortem analysis. Consider whether you need any of the following historical recording capabilities:

- Historical Alarms – Active, Acknowledged, Cleared
- Sequence of Events (SOE) – for any data type
- Control Commands – what, when and who
- Security – user login/out, access violations
- Configuration – online configuration changes

- System Events – significant system specific events
- Error Messages – application generated error messages
- System State – reconstruct system state through a database snapshot

The above recording features provide the capability to construct a complete audit trail of all significant user activities, field inputs and system responses. To be effective this recording capability must be supplemented with tools that provide:

- Viewing – drill down capability to find and view specific events of interest
- Trending – plot the data graphically to visualize patterns and correlations
- Reporting – generate reports automatically or on demand
- Analyzing – statistical and other in-depth analysis on selected data sets

Maintenance

Field maintenance is likely one consideration that is furthest from your mind when first looking at an M&C system for your proof of concept or pilot project. However, field maintenance is arguably one of the largest recurring costs your system will encounter over its lifetime. Take the cost of a single maintenance call multiplied by the number of calls per year for one system, which is then multiplied by the number of systems in the field and the number of years in operation and the importance of this factor becomes apparent.

So how do you minimize those costs? Considering that many systems may be in unmanned remote locations, a maintenance call will consist of one or two men, a vehicle and several hours driving to and from the remote site, it's easy to see that eliminating the need for direct hands-on will result in substantial savings.

Remote access gives you the ability to eliminate that overhead by connecting to your field systems via a communication link. Depending on your needs, that link can be secured in various ways to discourage unauthorized access. For maximum effectiveness, remote access should be available for all tools necessary for system operation, data analysis and diagnostics.

Field Upgrades

Another aspect of field maintenance that is particularly relevant when a large number of systems are deployed is the ability to easily and painlessly upgrade various components of the system. For instance, many vendors regularly release product updates that correct deficiencies or add features. If your system needs one or more of those updates, upgrading all systems in the field can be quite costly in terms of engineering effort and system down time. Another situation requiring a rollout to all systems is when the engineering team has corrected or improved the logic in the programmable components of the system.

To accommodate these scenarios, the M&C system should provide the ability to easily replace components without requiring a lengthy or complex upgrade process that increases downtime

and the risk of failure. Features that go even further in reducing the cost and effort of upgrades are the ability to isolate and replace a component without the need to take the entire system down and the ability to perform these upgrades programmatically rather than through a manual process.

Online Editing

When designing a solution in the lab, considering how it might be used in the field often comes as an afterthought. If your ultimate goal is to develop a field-ready solution, considering the following questions may help you identify some field requirements that have a significant bearing on the design of your solution and the selection of the M&C platform.

- Does your system require fine-tuning to compensate for varying field conditions?
- Do system operators need or want to adjust system behaviour to suit their preferences or to deal with an unusual situation in the field?
- Is it reasonable or acceptable to take the system down to make these changes?
- How difficult is it to make the required changes and integrate them into the system?
- How long does it take the system to restart? Does system size affect the start-up time?
- What level of system uptime is required?

If the answer to any of the above questions reveals that you need the ability to modify system behaviour regularly in the field and that system uptime is of paramount importance, you will want to consider an M&C system that provides online editing capability. This capability allows you to fine-tune various aspects of system behaviour and provides flexibility to accommodate dynamic field conditions while maximizing system uptime.

Tool Suite

Diagnostic and troubleshooting tools may not be high on the list of requirements you get from your users, but the ability to quickly diagnose a problem or even gain an additional level of visibility into the data and workings of your system can be an invaluable asset.

Communication monitoring, data simulation, data recording, charting and reporting tools all provide insight into various aspects of your system that assist in removing a level of uncertainty when troubleshooting unusual or unexpected behaviour.

Consider how you might carry out a post mortem analysis of a system failure, determine whether some behaviour or data is cyclic or random or attempt to correlate seemingly unrelated data, and the value of the additional insight afforded by these tools becomes apparent. Data simulation in particular is extremely useful in exercising the system to test its response to various input conditions and can be an effective tool for increasing and ensuring the reliability of your system.

If your M&C system does not come equipped with these tools, you might be tempted to integrate a product from another vendor, but consider the costs of that approach:

- Yet another software license to purchase and maintain
- Yet another point of contact for technical support
- Manual data conversion or extraction to provide input to the tool
- Dependencies on other tools
- Conflicts with other tools
- Ease of use

For these reasons, integrating multiple products from different vendors should be considered a last resort. The most cost-effective and typically the best approach is for these tools to be fully integrated and delivered with the M&C system.

Licensing Model

If you expect your system to grow in size, features or quantity, you will want to take a close look at the licensing model. This goes for all products used in your solution. Things to consider:

- Can a license be upgraded as the system grows in size or will you be required to purchase a new license?
- Can features be added incrementally with incremental cost or is each additional feature purchased in the future considered a separate purchase?
- Does the license come with a support agreement providing access to technical support?
- Is the license cost reduced when purchasing larger quantities?

Support Agreement

The support agreement has a direct impact on the maintenance costs of your system and deserves some scrutiny to ensure those support costs do not escalate out of control when you need to use that service. Areas to scrutinize:

- Are support staff available during your normal working hours or are they in another time zone?
- Will you have access to technical people who can delve into the depths of your system or are you restricted to canned phone support?
- Is 24x7 support available? Do you have to pay extra for it?
- Is there a limit on the number of support hours?
- What is the duration of the support agreement?
- Do all your technical support queries have to be routed through a single contact in your organization?
- Are on-site visits by technical support staff available?
- Can the support agreement be extended and at what cost? Are longer terms more economical?

- Does the support agreement include access to maintenance upgrades? What about access to major releases?

Conclusion

The list of things to consider when choosing an M&C platform is almost as endless as the number of applications for such a versatile product. In this paper we discussed just a few of the considerations that can significantly affect system cost and probability of a successful field deployment.

As the heart of most process control systems, the M&C platform plays a pivotal role in determining and controlling the total cost of ownership of the system. The total cost of ownership is what the system will cost over its lifetime and includes the one-time capital costs and the potentially more significant recurring operational and maintenance costs.

Determining the total cost of ownership can be challenging, but understanding where and how the costs are incurred is the first step in controlling them. Be aware of the various growth phases your system will experience as it moves from concept to full-scale field deployment and select a system with the features necessary to facilitate that growth.

Equally important to controlling costs and ensuring a successful rollout is understanding the deployment process and maintenance requirements of a field solution. Select a system with features that allow you to engineer low cost solutions for operation and maintenance.

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