Innovations with SCADA and PLC

By A Bosman, GE Intelligent Platforms

Today's solutions for automation must be robust and ready for tomorrow's technology-fluent users - and also provide the application domain expertise to ensure that both ageing and new industrial infrastructure benefit from optimal asset performance and maximum uptime.

Programmable logic controllers (PLCs) and supervisory control and data acquisition (SCADA) systems have been around for nearly 50 years, and they are arguably two of the most widely used products in industrial automation. The functionalities of both PLCs and SCADA have evolved over the years with the changing needs of industry and the technological advancements.

Progress in IT and communications has revolutionised how we communicate data and make decisions.

Process automation solutions can deliver additional performance and productivity by leveraging technology principles that are powering the 'Information Age' and combining them with the unique domain expertise for the required Industry application. The two key trends in industrial automation are rapid evolution of collaborative technology, and the ability and need to embed pre-engineered application domain expertise in automation platforms.

High-performance automation platforms enable the connectivity and computing power required for collaborative automation. Pre-engineered solutions provide pre-programmed, object-oriented functions to optimise performance for various applications. Users will be able to leverage proven, standardised modules to configure a customised solution for their application, and thus help reduce utility and raw materials costs as well as optimise other key performance indicators (KPIs). The resultant benefits are optimal asset performance, maximum uptime, and lower total cost of ownership.

Leading-edge automation technology has the ability to remain contemporary across multiple generations of underlying semiconductor chipset technologies, while application-specific domain expertise deployed through pre-engineered libraries in the automation layer build a foundation for a successful automation framework of the future. The risks associated with technology obsolescence and application deployment are highly reduced with control and computing solutions in standard and custom form factors that now migrate over multiple chipset lifespans. Further risk reduction is achieved by using proven pre-engineered process libraries to standardise across multiple plants and utilities delivering repetitive and consistent deployment.

Overview of a pre-engineered solution

One might ask what a pre-engineered solution consists of and what benefits it brings. By combining an automation layer with vertical domain applications expertise, customers purchase a standardised solution that requires only configuration as opposed to programming. Pre-configured libraries allow the user the flexibility to select or bypass functionality according to their plant design. The benefits include (but are not limited to) reduced time of development and project implementation. Overall savings from these development and implementation efficiencies would be expected to be around 30%. The risk is reduced through the repeatability of proven algorithms and pre-engineered solutions that have been optimised over time, which results in customers being more competitive.

In order for this to be successful, the minimum criteria for the automation controller logic would include monitoring, conditioning, control, alarming and statistical blocks. These blocks need to be proven in use for the application that they are to be used in. They also need to be arranged and linked to perform the control strategy required for the plant or process. To provide visibility, the blocks need to be linked to operator graphics where templates have been pre-designed and engineered to work with the automation controller logic blocks. SCADA forms an integral part of the pre-engineered solution for operator interface. SCADA comprises a set of graphic objects to control and monitor equipment or processes via the automation controller function blocks and programs. Common components in a user inter

BTU – British Thermal Unit
CD – Compact Disc
CPU – Central Processing Unit
DCS – Distributed Control System
DVD – Digital Versatile Disc
IT – Information Technology
KPI – Key Performance Indicator
LLC - Limited Liability Company
PAC – Programmable Automation Controller
PLC – Programmable Logic Controller
SCADA – Supervisory Control and Data Acquisition

Abbreviations

face are animated symbols, pop-up mimics, trend objects, tags and tag groups, security (which is linked to navigation and functionality), statistical information and data collection.

To illustrate the benefits of a pre-engineered solution to a given industry vertical, we can look at how such a strategy would impact the water and wastewater industry. A typical application for pre-engineered solution for the water industry would control both water treatment and conveyance. Within the main control strategies, there are subcategories where repeatable tasks or functions may be used in one or all of the main control strategies. A pump lift station used in the wastewater industry may share common strategies and functionality with a conveyance pump station. As such, common templates in many cases can be leveraged for both applications.

Filter control may contain multiple strategies. For example, the filter may be a membrane filter that needs to be replaced once the differential pressure increases above a certain value, whereas with a sand filter this would initiate a backwash sequence.

Treatment for potable and wastewater are, of course, very different processes and operations, and each requires a completely different control strategy. All wastewater treatment plants, however, have common control strategies and the common goal of transporting wastewater to the plant via pump lift stations, treating the wastewater and returning the treated effluent to the discharge site. The pre-engineered solution will contain most if not all of the control strategies, and all the user needs to do is follow a simple process of selecting the required strategies. In the case of a pump lift station, for example, the user would enter the number of pumps, the kilowatt rating of the pumps, which pumps are on duty and are on standby. The pre-engineered solution also provides flexibility where parameters can be modified, such as the percentage of time that a pump must operate versus it rests on standby. The end result is that a user need not be a programmer. The configuration should be as simple as programming a domestic washing machine: Select fabric type, temperature, time and drying cycle speed, as each selection changes the way that the washing machine will operate.

Leveraging latest technologies

PLCs have always lagged behind the commercial and military sector in terms of the technology being leveraged when producing controller processing units. The reasons are numerous, and include firmware development for each new processor that is used when manufacturing the central processing unit (CPU) on the PLC to ensure that the CPU communicates and operates seamlessly with the other cards on the backplane, which may be from a different generation. The new CPU also needs to be tested with the instruction set from the PLC programming environment to ensure that the controller behaves as expected, as failure or malfunction could result in substantial loss due to equipment failure, process disturbance and even human injury. All of this rigorous planning and testing causes delays when bringing new automation technology to the market. As a result, automation technology historically lags behind in the underlying semiconductor technology when compared to personal or military computing and communication technologies. This technology lag and the ever shorter lifespan of semiconductor products require that automation manufacturers hold large stocks of components to ensure product availability across its intended lifetime. With the fast pace of change in today's world, what we purchase today is outdated tomorrow, meaning that the chipsets used in most PLC CPUs are outdated by the time the CPUs are released to the market.

The programmable automation controller (PAC) follows current technology very closely by redefining the architecture of the CPU, specifically the firmware. In the firmware, the control engine is separated from the operating system. As such, the application is portable across the various semiconductor technologies, as the application is independent of the operating system.

This is the key concept in the development of PACs that offer faster processing speeds, larger memory and multi-generation application program portability compared to traditional PLCs. Reliable and high-performance military-grade single board computers are now affordable due to the high volume of production, and now form the core of PACs. This new development, adoption and widespread use of PACs have enabled the development of pre-engineered solution libraries being made available at affordable prices.

Current and future software environments

Software environments for programming PLCs have not changed much since the invention of the Windows operating system, with only new features and functions being added. The programming environment conforms to the IEC 61131 [1] standard with five programming languages being supported by most if not all vendors. There are, however, subtle differences that are normally related to the environment in which the programming takes place as well as the structure of the program. Currently, programs are backed up onto a flash disk, external hard drive, CD, DVD or a network drive.

Software environments for SCADA are unique in that there is no standard format or language that is used when designing the SCADA drawings and functionality. Most SCADA vendors do, however, offer smart objects in which much of the scripting has been done in the background where objects have behaviors and attributes attached to them. For most SCADA projects, the programming is limited to dragging and dropping graphic objects into a workspace, then linking these objects to a PLC tag to enable animation and control. Trends and alarms can be overlain onto the graphics page or positioned on any or all screens. Navigation is done by means of selecting a zone or button on a screen that will open the page for which the operator is searching. Most SCADA packages can connect to multiple hardware vendors'

equipment, with many offering added features when connected to their own brand of PLC or PAC hardware. In the future, pre-engineered solutions will be downloaded and implemented, shifting the focus to continuous improvement as opposed to programming a SCADA just to obtain visibility into operations. Cloud computing affords customers the opportunity of storing backups on cloud-based servers that can be located offsite and even on another continent to offer better disaster recovery. Pre-engineered solutions can be developed by experts and loaded onto the cloud server where new customers can purchase the pre-engineered solution. This guarantees operability while reducing risk and development costs. Currently, most of the vertical pre-engineered solutions will be vendor-dependent, but hopefully in the not-too-distant future a standard programming environment will allow applications to be freely converted between different vendor platforms or for completely vendor-independent pre-engineered solutions to be realised.

When PAC hardware technology is combined with cloud computing and pre-engineered solutions, engineers and end-users will realise even more benefits. Risks and engineering costs will be substantially reduced, and hardware and program migration will be simplified. This will give customers a competitive advantage over those who do not embrace the new technology, as control philosophies are proven in use and the added security through business continuity during disaster recovery is immensely improved.

Case studies of pre-engineered solutions

YM Krisha Sugar SSK implemented a boiler control pre-engineered DCS solution to drive a 16 MW steam turbine where the fuel was biomass with varying BTU values. The Indian company anticipated expansion of its plant, and thus needed greater control and automation capabilities at the cogeneration plant that operates on bagasse from a sugar mill. The ultimate goal was to reduce both startup time and production downtime to improve overall energy efficiency, but all of this had to happen without compromising the quality of the sugar.

The pre-engineered DCS solution gave engineers and operators ability to monitor, measure and analyse various operations within the plant in real time, including steam, power and water consumption, production efficiency, molasses output, steam generation, fuel quantity, and water quality and quantity. YM Krisha Sugar was indeed able to achieve its goals of faster startup, reduced downtime and improved energy efficiency, as well as a 10% reduction in water treatment chemicals.

Also faced with a diverse biomass feedstock, Ramanik Power and Alloy Pvt, the largest private manganese mining company in India, realised full payback on its investment just six months after implementation of a boiler control pre-engineered solution. Engineers and operators sought to increase the control and flexibility of the 6 MW facility, which is operated with a challenging biomass mixture of fuel types that includes rice husks, sugarcane thrash, maize cobs, soybean stalks and coal. With help from contracting engineering, procurement and construction firm Teko'ner Technologies and local systems integrator Chemtech, Ramanik was able to deploy the pre-engineered solution while the boiler DCS controls were upgraded, and since has realised improved reliability, transparency and ease-of-use in the control system. Ease-of-use was also a key goal for Doyon Utilities, LLC after winning a privatisation contract to manage the electrical, natural gas, steam and potable water distribution and wastewater collection systems for US Army forts Wainwright, Richardson and Greeley in Fairbanks, Anchorage and Delta Junction, Alaska, respectively. The Fairbanks-based company found itself faced with aging infrastructures at the three forts. In order to quickly achieve upgrades to the boiler control systems as well as standardise control among the far-flung military bases, Doyon chose to use a scalable pre-engineered control solution that could be easily implemented as existing plants were retrofitted. By using pre-engineered control software, Doyon had a turnkey that provided accurate control and information management that could be expected to remain effective through the 50-year life of the contract.

Conclusion

The core of an automation solution is its controller hardware and associated software including the application program. As most vendors are closing in on the ability to provide generic features and functionality, the biggest risk factor now shifts to the reliability and performance of custom-engineered programs. A pre-engineered solution mitigates these risks as the program has been tested and enriched for optimal performance through learning from proven usage. Further security for disaster recovery can be improved by wisely utilising cloud-based storage and computing. Performance and reliability of PLC/PAC/DCS hardware systems are made possible by taking advantage of military-grade single board computers that have the additional benefit of economies of scale in addition to better specifications.

Reference

[1] IEC 61131.1993. Programmable Controllers Package.

Acknowledgement

Presented at the Industrial Automation Conference – SCADA, DCS, PLC. IDC Technologies. 22 – 24 May 2012.

Arthur Bosman studied communication electronics from1 1982 – 1986 and has managed five electrical workshops in the textile industry. He started an integration company in 1991 and implemented projects including automation in various verticals and specialised in process control. He joined GE Intelligent Platforms in 2010, his current role being sales manager, infrastructure and manufacturing in Sub Saharan Africa. Enquiries: Tel. 031 5833640 or email arthur.bosman@ge.com .

About the author