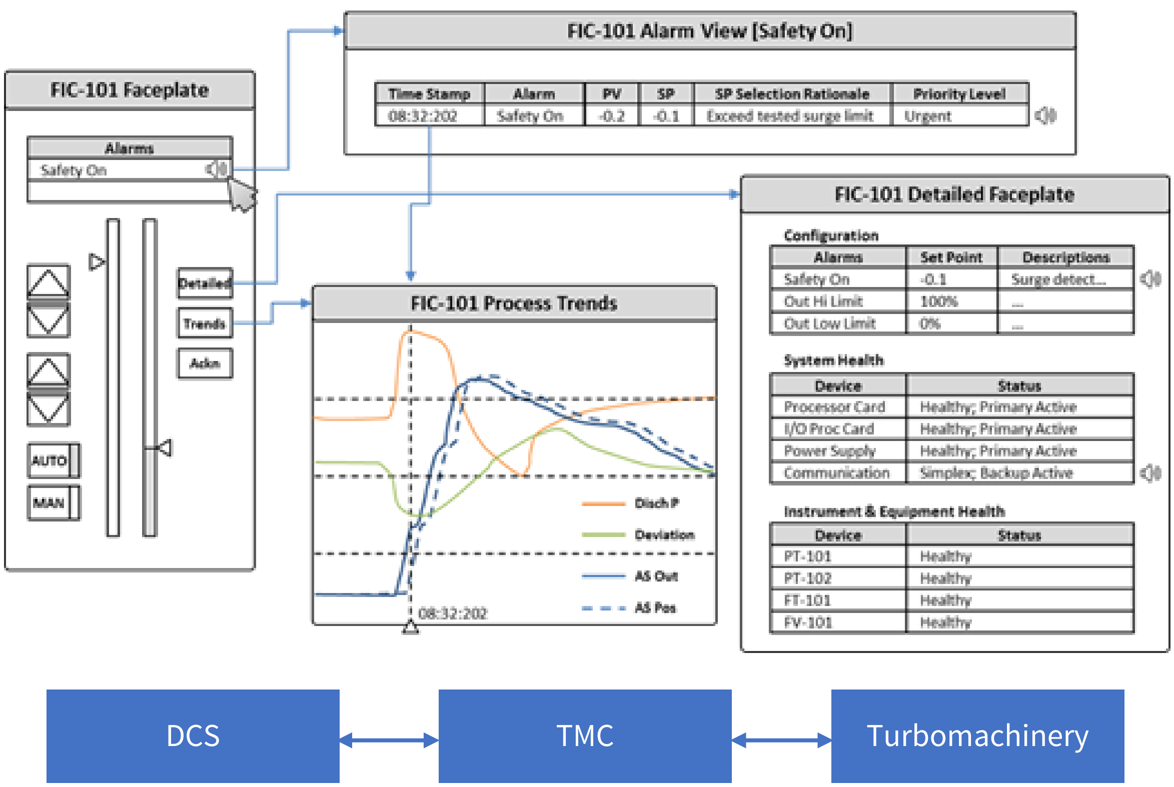
Expertise in Turbomachinery Controls

WHITEPAPER

Reduce Risks and Improve Performance with Packaged Unit Control Solutions



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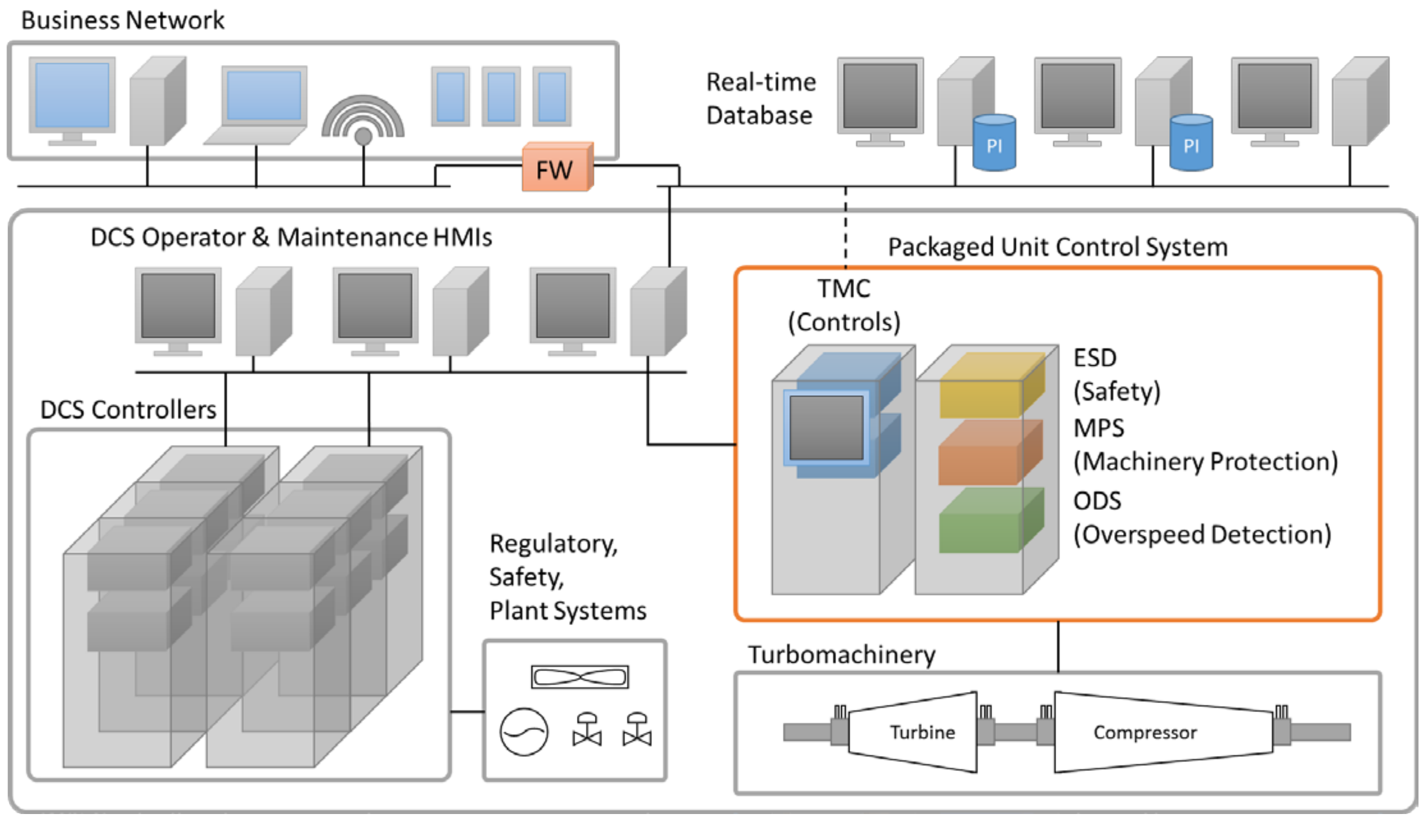


Introduction

Turbomachinery control (TMC) applications such as antisurge and load-sharing, as well as hardware platforms on which they are deployed, have been evolving through faster system response, higher availability, and standardization. Packaged turbomachinery control solutions (often referred to as Unit Control Systems) horizontally integrate critical control and safety functions. This is considered important as such solution development and support requires a strong expertise that spans across in instrument and controls, process, and machinery.

At the same time, as end users continue to streamline plant operations through consolidation of resources, it is becoming increasingly important to have a consistent and well-integrated plant monitoring and control environment. This improves operators' situational awareness – helping them to respond to abnormal situations quicker with less errors.

However, due to the typical project execution structures involving multiple contractors and suppliers, achieving deep and consistent integration between TMC and primary operator interface, typically provided as a part of distributed control system (DCS), can be challenging. Specifically, this can be attributed to each contractor and supplier executing highly segmented project scope, while communicating via the exchange of static design documents.

In this article we explore an optimum architecture for turbomachinery control (TMC) solutions that overcome these challenges and deliver truly integrated operator environment. By creating seamless bridges between Turbomachinery, TMC, and DCS, the solution achieves maximum process performance, reduces project execution risks, and continues to add value over its lifecycle.

Evolution of turbomachinery controls

Turbomachinery trains, often times consisting of various stages of centrifugal compressors with gas/steam turbine or electric motor drivers, are critical parts of continuous processes. Availability and efficiency of these turbomachinery trains directly impact the availability and efficiency of the respective process units. In other words, they are the heart of the process.

Process conditions surrounding these machines are continuously changing. These changes may be environmental, planned, or unplanned. For instance, seasonal variations of ambient temperature will affect the density of the air and processes that utilize it. Gas compositions may change because of different mix of feedstocks in use. Or there could be an upset upstream or downstream of the machines due to equipment malfunctions.

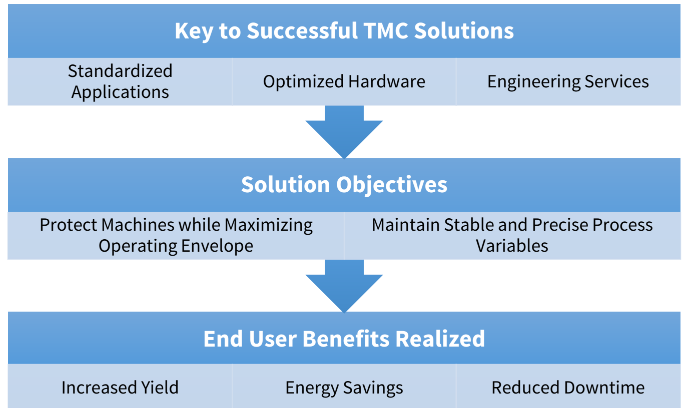
Therefore, it is imperative that they be equipped with robust TMC solutions that will not only provide accurate and stable control of process variables under steady conditions, but also detect and prevent fast occurring process upsets from resulting in downtime.

For instance, if a TMC solution is designed to prioritize machine protection over stable process control, it can overreact to process disturbances. While this may protect the machine from getting damaged, it will likely result in frequent machine and process disruptions. It also means increased safety margins, which limits the machine from attaining its maximum efficiency and throughput.

In contrast, if a system is designed only to provide stable process variables, control responses during upsets may be too slow to protect the machine from surging, potentially resulting in compressor mechanical damages that require lengthy shutdowns for repair.

In order to meet the challenge of achieving these seemingly conflicting objectives, a careful selection must be made when deploying TMC solutions. Typical requirements are utilization of advanced algorithms that offers adaptive controls and control hardware platform optimized for high speed response and maximum availability.

Equally important to having a strong technology base, if not more, is the engineering expertise offered by a TMC solution provider that ranges from instrument and control valve selection, process piping review, control strategy development, to ongoing optimization of the systems over its solution lifecycle.



Evolution of process control and monitoring technologies

As TMC evolved over time, so did DCS backed by rapid advancements in computer and networking technologies.

Integration of DCS with higher level business systems such as enterprise resource planning (ERP) and manufacturing execution systems (MES) enables end user to dynamically adjust the plant operation in accordance with available resources and market conditions.

Thanks to this vertical integration, much of the plant operations under normal process conditions can now be automated, enabling end users to run the plant with a smaller number of operators. However, in abnormal or infrequent operating conditions, including plant start-ups and shutdowns, turn-down and recovery operations from incidents or equipment malfunctions, decisions that experienced operators make remain instrumental to keeping the plant running safely due to the lack of automation under such conditions.

Improving situational awareness and knowledge capturing

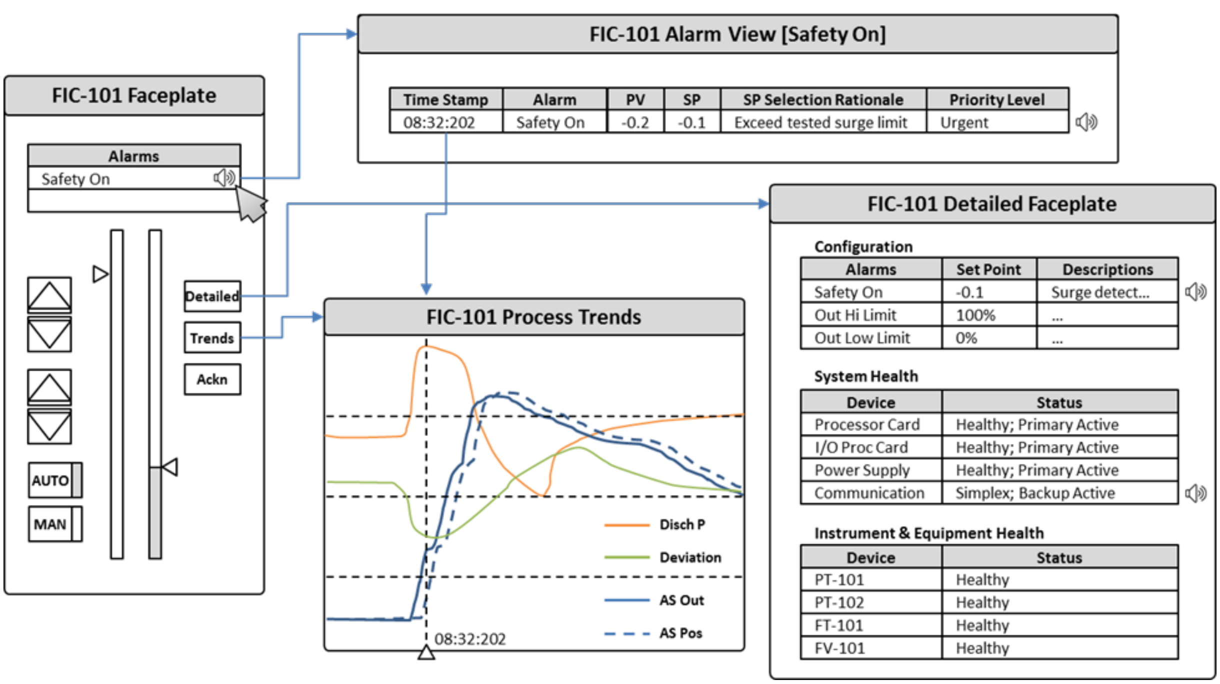
The phenomenon known as the “Great Crew Change” poses a challenge here. According to the American Petroleum Institute (API), nearly half of the current oil and gas workforce is projected to retire in the next 5 to 7 years. This can create a serious gap in the plant workforce including the retirement of skilled operators who have been trained through real-life experience of handling abnormal operating situations. In order to account for this potential skills gap, it important that future operators have access to a decision support system with optimized alarms, detailed diagnostic information coming from field instruments and sub-systems, time-synchronized logs of ongoing events, as well as standard operating procedures (SOPs) outlining causalities and recommended actions.

With the shrinking and rapidly aging workforce in the industry, consolidation of previously dispersed operator HMI screens, development of remote control and monitoring solutions, and mitigation of associated cyber security risks have become critical in designing a plant. This “truly integrated” operator environment will not only improve operators’ situational awareness – helping them to make quick yet accurate decisions under abnormal situations – but also enable the team to capture valuable operational knowledge.

A stepping stone for truly integrated systems

In order to provide a true integration between TMC and DCS without inflating the amount of engineering effort and costs, it seems that a both strategic and technical approach is needed to streamline the project execution work. CCC’s TMC solutions are meticulously standardized and refined from control applications to hardware. Leveraging this can simplify the DCS integration process from both physical and software perspectives.

Standardization on physical interface includes network protocol and architecture used to communicate the data between the two systems, which will not only simplify the engineering process for contractors in designing network architecture, but it would also significantly reduce the time necessary to establish communications between TMC and DCS during integration factory acceptance test (IFAT) which will result in additional cost savings.



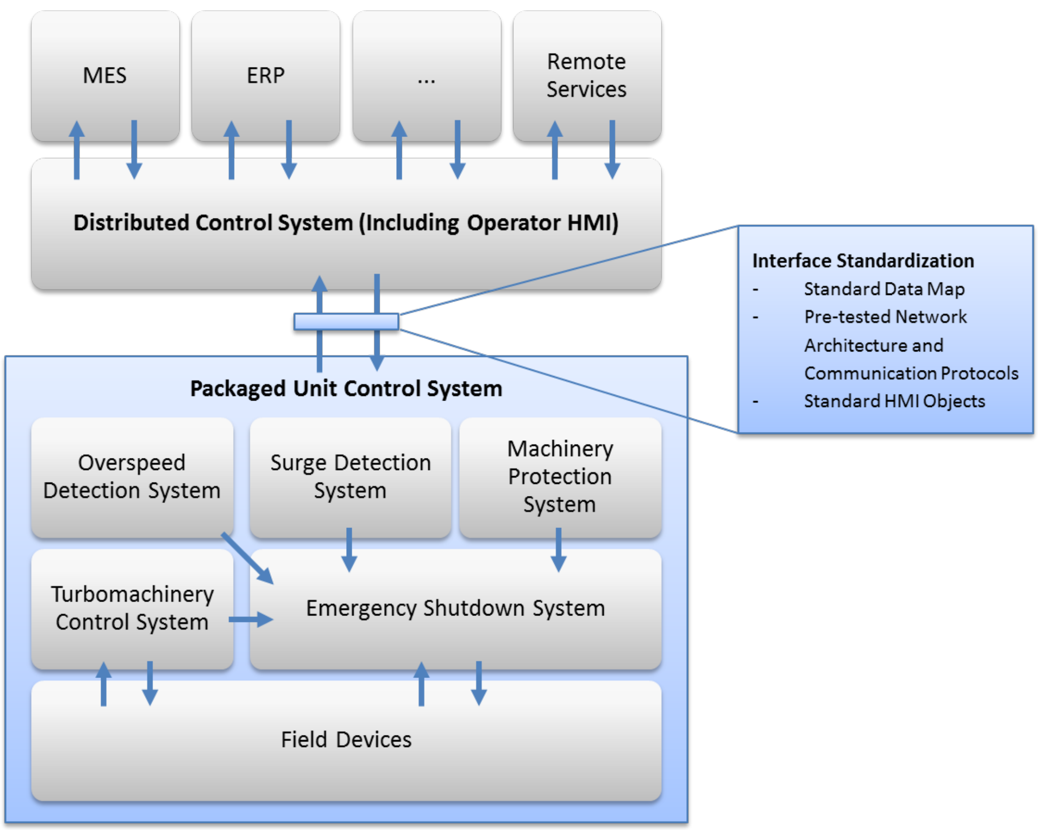
Standardization also enables automation contractor(s) to keep project costs and quality on target by allowing easy estimation of I/O counts, planning for network bandwidth, and standardizing on system specifications. It also enables early review of HMI designs with end user operators, thereby contributing to attaining higher customer satisfactions.

When developing standard designs for TMC application interface, a careful consideration must be taken to ensure that the display modules follow the same HMI standards as the rest of the DCS HMI. This includes faceplate layout, alarm integration and process trends. This reduces potential operator errors and eliminates the need for specialized trainings. Integration of rationalized alarms, instrument and equipment diagnostic data and critical loop configuration parameters are all keys to creating high performing operator interface.

Future of packaged turbomachinery controls solutions

Today, CCC provides horizontally integrated (i.e. packaged) turbomachinery control solution that combines turbomachinery control system, machinery protection system, overspeed detection system, and surge detection system. This solution package called Total Train Solution™ achieves high engineering efficiency, reliability, and ease of support by fully embracing modular engineering practice.

CCC is currently working closely with DCS manufacturers to enable seamless vertical integration of the Total Train Solution® package for minimizing project risks even further while making the operator interface more functional and effective.



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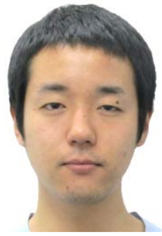

Shun Yoshida is a Product Manager at CCC (Compressor Controls Corporation). Shun joined CCC in 2012 as a Project Engineer where he executed engineering designs of various turbomachinery control solutions around the globe. As a Product Manager, he is responsible for product ideation and development to support the company's growth vision. He holds a B.Sc. in Aerospace Engineering from Iowa State University of Science and Technology with a minor in Non-destructive Evaluation (NDE).