Digital Transformation of **Industrial Automation Systems**

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Executive Summary

This paper discusses the digital transformation in the space of monitoring as well as controlling systems for manufacturing, both in continuous/regulating and discrete, industries. Digital transformation is a much-hyped and over-used term today. It is essential to sync-up on the scope of digital transformation, before getting in to the details of this paper.

Most of what digital technologies can do today was possible earlier too, but with huge investment of time and effort. The advancement in technology have made it easily available (anywhere, anytime, any device) and the cost & planning required for scaling (processing power, infra, platform, software) has significantly reduced. This caused digital transformation to be a disruption and triggered widespread adaption.

To set the background, we need to understand the current/ traditional industrial automation systems. The paper further elaborates on the transformation of the systems and processes by explaining the key trends and relevant technologies.

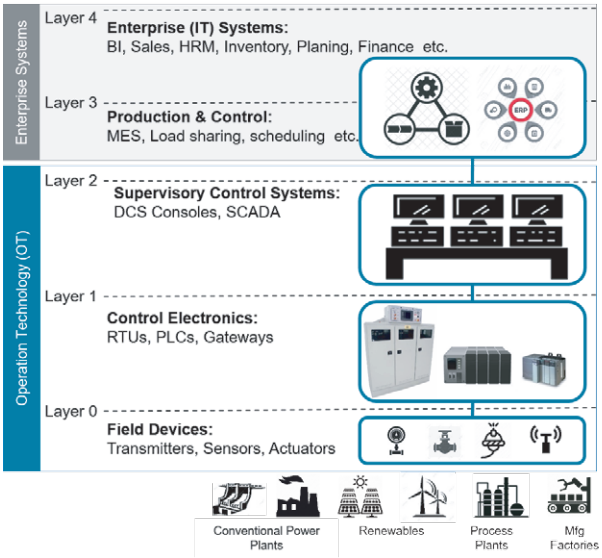
In the industrial automation (domain considered here) systems where computers and software are in place for last many decades - transmitters, actuators, PLCs, Gateways, RTUs, DCS, SCADA, APC systems, MES etc. are some of the commonly used sub-systems. Of late, these sub-systems are further enhanced to do more than "monitor & control", such as the asset tracking, asset management, etc. So, the scope of discussion also includes such enhanced functionalities, of control and asset management systems, which are now unleashed by digital technologies.

Digital technologies considered here are IoT, cloud, Analytics, AI, AR/VR, Mobility, Edge Computing and Smart Sensors. The latest entrants like Blockchain and 5G are excluded since their impact and use cases with industrial automation systems are yet to emerge. This paper also summarizes various critical components, which ought to be considered while transforming the conventional control and asset management systems with digital technology enabled ones.

Brief Overview of Traditional Industrial Automation Systems

From the functionality perspective, electronics and software systems in industrial automation space can be structured in multiple layers as depicted in the picture below. Layer 0 is about the transmitters/sensors and final control elements which collect the real-time data and also get the control actions executed. Layer 1 does the interfacing, processing of data and control functionalities as per the pre-defined programs and commands from upper layers.

Layer 2 is the data presentation and human interaction layer, which encompasses control consoles and the large-scale software sub- systems like DCS and SCADA. Layer 4 handles plant(s)-specific high-level management such as load sharing, scheduling, etc. And layer 5 is pure enterprise resource management layer with applications like business intelligence, resource management, planning, HR, finance etc. Layer 0 to 3 are the operational systems (OT) layers while Layer 4 and 5 are the enterprise layers, known as IT layers.



Changing Expectations of Plant / Factory Operators and Owners

What and Why is It Happening?

With the conventional systems in place, plant/factory operating personals are well in control with plant/factory processes and asset management. These systems provide enough information related to the plant/factory process and assets and also provide enough tools to analyze and correlate the data to find out reason for a specific alarm/event.

Traditional plant monitoring mechanisms, which are

proven and reliable, are transmitters, actuators, PLCs, Gateways, RTUs, DCS, SCADA, APC systems, MES, etc. are helping the plant owners to address these fundamental "what and why" needs. The huge amount of data captured in the historical database to be used for post-event analysis are hardly ever used.

What could Happen and How to Control Future Scenarios

With the demand for high-performance requirements (productivity, efficiency, availability, safety, scalability, speed, etc.), there is a need to know more than just what and why. Organizations are now looking at forecasting the future scenario and to take appropriate actions in advance to gain more control than ever. This calls for seamless integration of data, application of artificial intelligence and availability of information anywhere, anytime etc. Addressing these needs is exactly what digital transformation is doing now. Of late, many front runners have embarked their journeyon digital transformation by implementing digital technologies based sub-systems integrated on top of the existing traditional control systems. This trend is expected to continue and strengthen further in line with evolution of digital technologies. Some of the key trends which are gaining momentum are listed below:

- Enhanced data capturing related to the manufacturing processes, health of assets, safety and security related (smart sensors, cameras, drones, etc.) systems
- Wireless enabled sensors, data concentrators and gateways – reducing the cabling requirements significantly
- Seamless data integration and data availability – IoT and private, public and hybrid cloud
- Data analytics for forecasting process conditions and asset health for proactive control and preventive maintenance (Analytics and AI)
- Moving the computing to edge devices, to act then and there based on business intelligence / the big picture (embedded edge analytics governed by insights from cloud-based business intelligence)
- Bespoke visualization, anywhere, anytime (over the web and/or mobile)
- Empowerment of operation personal with all relevant data/information (AR/VR/MR, Cloud and AI)
- Safe and secure operations (drones, video streaming and analytics)

Elements of Digital Transformation in Industrial Automation Systems

To reap the benefits of digital transformation industrial automation systems, we need to address three fundamental issues, such as the connectivity of physical world to the IT world (and how to effectively structure the IIoT), handling the huge volume of data to derive insights and finally to present it in the required form as needed. Smart sensors, IIoT & Cloud, Big data Analytics, Edge Computing, next gen UI and mobility are some of the key elements to realize this, which are discussed in further detail.

Smart Sensors: Smart sensors have a key role in digital transformation of industrial control systems. They are much more than devices converting physical variables into electrical signals – IIoT connectivity and built-in intelligence are expected to unleash benefits related to predictive maintenance, flexible manufacturing and improved productivity.

The smart sensors also come with features such as wireless connectivity, data-preprocessing capability, self- identifying, self-validating, self-diagnostic, self-calibrating, very low power /self-power operated, small size (unobtrusive), robust and of low cost. Smart sensors and smart sensor networks are also capable of handling limited scope of edge computing to infer conclusions/insights about problems ahead. Smart sensors and smart sensor networks not only capture the essential parameters to control the assets but also monitor the health of these assets.

Such wireless smart sensors also reduce the filed cabling significantly.

Cameras and drones are another set of smart sensors gaining momentum in industrial control scenario, by way of streaming the real-time visuals to ensure safety and security of operating conditions and assets.

IIoT and Cloud: These technologies are the backbone and game changers in industrial control systems. IIoT and cloud-based systems offer significant advantages by way of consolidation of data (both monitoring & control and asset management related), global access to data, ability to easily integrate with analytics &

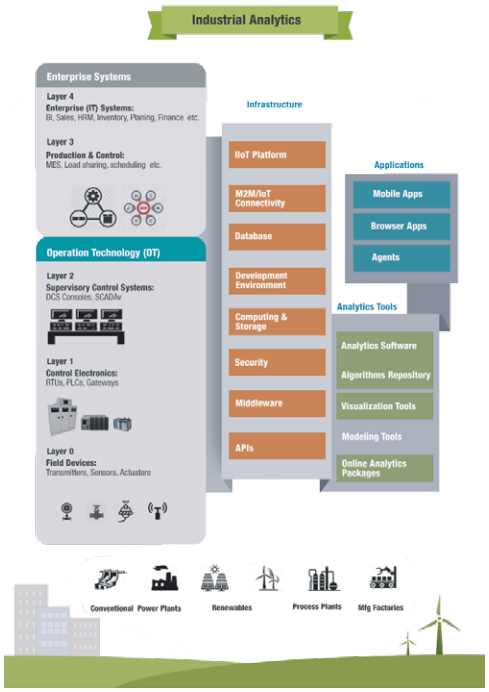
AI. This will help to create new technologies to solve problems, enhance operations and increase productivity.

There are different IIoT technologies available in the market for an OEM/end-user to choose from. Some of the leading OEMs have made major investments and introduced custom frameworks. Major software players are also offering industry-specific solutions around their cloud platforms and making a big push to enter into the IIoT market.

Many leading OEMs are making their presence by consolidating their products and services as IIoT solution, while they are working at the background to enable their products with digital technologies. Apart from all the above- mentioned products/frameworks, there is notable developments happening on open source-based IIoT solutions.

In this scenario, one of the major challenges for the end-users is to choose the right technology that can fit to the current and future needs. This is one of the key factors which defines the success of digital transformation for their plant/factory. The available options need to be carefully evaluated and the right one needs to be chosen based on the volume, velocity, variety, scalability and security requirements of data to be captured.

Analytics: Industrial Analytics is the collection, analysis and usage of data generated during industrial operations. This is enabled by advancements in connectivity (IIoT) and improved methods for analyzing and interpreting data (Machine Learning). Analytics leads to increased revenue, customer satisfaction and product quality. Predictive and prescriptive maintenance of assets and physical security are the most important applications in near future.



Edge Computing: Edge computing brings the power of data processing and analytics down to the edge of the network and to the physical world. Edge computing address the latency, efficiency and security issues effectively. Filtering and processing at the edge helps to send only the required data to the cloud and reduces traffic on networks, significantly.

Highly intelligent sensors and network of such network sensors enable edge computing. However, it may take years to have such infrastructure established. In the meantime, there is a challenge of releasing edge computing making use of existing conventional infrastructure. This can be done with computing resources existing on the path from sensors to the cloud. These resources could be the data concentration units (PLC/RTU), gateways, network switches, etc. Unlike legacy sensors, these resources can understand the languages the internet uses, like JSON, RESTful APIs, JavaScript, etc. Also, they can run an operating system or have a built-in TCP/IP stack or web server as needed.

Next-gen UX, AR/VR/MR and Mobility: Modern workforce needs to be supported with next-gen UI/HMI realized systems with new set of technologies and standards (ISA guidelines) to have situation awareness and high performance anywhere, anytime and on any platform. Integration of data from multiple sources is needed to improve situational awareness by way of intuitive visualization and leading to the most appropriate actions.

Model-based HMI software enables features such as on-the-fly configuration, auto generation of HMI and significantly eases development, deployment, and maintenance. Centralized (cloud-based) management, HMI designed as per ISA guidelines and the usage of technologies like AR/VR/MR help operators/technicians to see complete asset-related data, which significantly improves situation awareness and response.

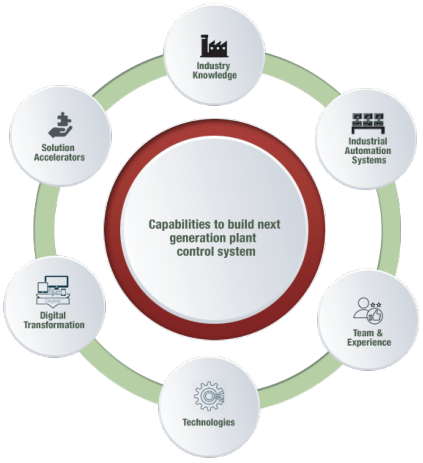
What a Partner Ought to Be

Today, OEMs are under pressure to accelerate the digital transformation journey. Often, in-house teams and incumbent service providers struggle to bring the needed out-of-the-box thinking and innovation component to it. A right partner chosen for this transformation journey is important to make it successful.

An ideal partner is expected to have in-depth knowledge in existing/conventional industrial automation system

components, application domains (respective manufacturing plant & process), conventional and digital technologies and experience with large-scale development projects, to make this journey fruitful. Willingness to invest and build solution accelerators can significantly accelerate the transition programs. Global foot-print and flexible engagement models are other key factors which one should look for while choosing the partner for digital transformation program.

NextGen Plant Control/Mgmt. Systems – QuEST Capabilities Summary



Conclusion

Industrial control systems are in transition. They are being transformed to do more than just "monitor & control", by integrating with additional intelligence at every level to have predictive asset life-cycle management, advanced stakeholder-experience and added security & safety. This transition is not a disruption anymore and is already underway.

Another important change in the scenario is the integration of electrical, safety, telecom functionalities along with the process control functions in DCS. Some of the leading OEMs have already been offering this while others are trying to follow by introducing their next gen DCS. This is not elaborated in this paper since it does not fall under the digital transformation category.

Today, the challenge for OEMs is to embrace both of the above-mentioned changes at the earliest to increase their market share. Digital transformation journey of industrial automation systems has just begun. This paper elaborated some of the key elements and functionalities of the envisaged modern industrial systems. However, it is not complete, it is emerging. The shape of next-gen industrial automation system is much more than what industry is discussing today and it is yet to emerge. It is very important to have out-of-the box thinking and innovation to build the new systems.

ENERGY DIARY

Niti Aayog Overrides Concerns Of Manufacturers And **Bats For Fast Tracking Electric Two-Wheelers**

India's central think-tank, NITI Aayog has issued a virtual ultimatum to scooter and motorbike manufacturers to draw up a plan to switch to electric vehicles, days after they publicly opposed the government's proposals saying they would disrupt the sector, Reuters reported quoting two sources.

At a meeting both parties had discussed the issue. Government side said switching to EVs was of national importance so that India does not miss out on the global drive towards environmentally cleaner vehicles, one of sources said. But industry executives responded that a premature switch with no established supply chain, charging infrastructure or skilled labour in India, could result in India losing its leadership position in scooters and motorbikes, the second source said. "There were clearly drawn out positions," said the source, adding there were "strong opinions" at the meeting.

NITI Aayog officials finally told executives from companies including Bajaj Auto, Hero MotoCorp and TVS to do the needful giving them two weeks to come up with the plan, according to one of the executives.

The think-tank, which is chaired by Prime Minister Narendra Modi and plays a key role in policymaking, had recommended that only electric models of scooters and motorbikes with engine capacity of more than 150cc must be sold from 2025, sources told Reuters.

Automakers opposed the proposal and warned that a sudden transition, at a time when auto sales have slumped to a two-decade low, would cause market disruption and job losses. India is one of the world's largest two wheeler markets with sales of more than 20 million scooters and motorbikes last year.