

Edge Technology

Accessing and Integrating Critical Isolated Data
(The Truth Behind the Hype)



Introduction

Industrial markets are talking about edge technology and the remarkable advantages it brings to IIoT and Industry 4.0. Edge has become a buzzword with many voices defining it and maintaining how it should be done. The claims have led to a lot of misconceptions as to what edge technology is, what it does, and who needs it. This white paper is designed to answer some of those questions and provide a guide for users, systems integrators, and OEMs who want to explore this important IIoT advance.

Does Edge Technology Take the Place of the Control System?

Prospective users ask if edge technology is supposed to replace SCADA or their control system. The answer is no. Edge technology – whether edge gateways, edge devices, or the new edge controllers – are complementary to control systems. They’re designed to make systems smarter. An edge device

works in concert with the control system to provide access to data not currently available.

As Figure 1 shows, every industrial control system connects and collects data from sensors and actuators, but there are some sensors and actuators that are not connected. These isolated production elements provide no data to the control systems and make it difficult for businesses to respond rapidly to complex problems or achieve desired business outcomes because they don’t have the whole picture. Getting data from these disparate machines that are not currently connected due to factors such as incompatibility or proprietary software is the benefit of the edge layer. The edge device takes control system data and non-control system data and integrates it, so users have one view of the entire operation and make better decisions with this holistic view of the equipment than would be possible otherwise.

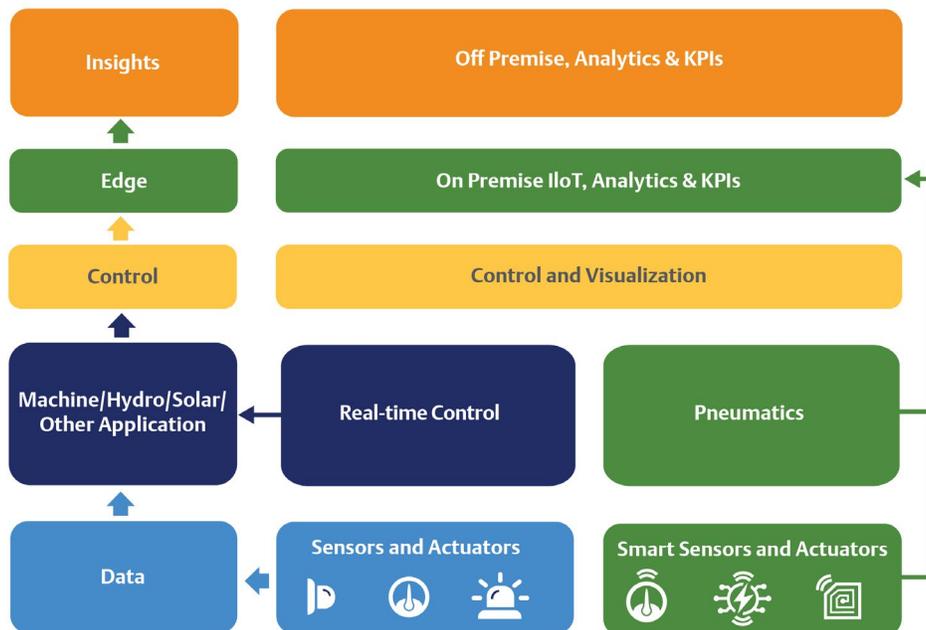


Figure 1

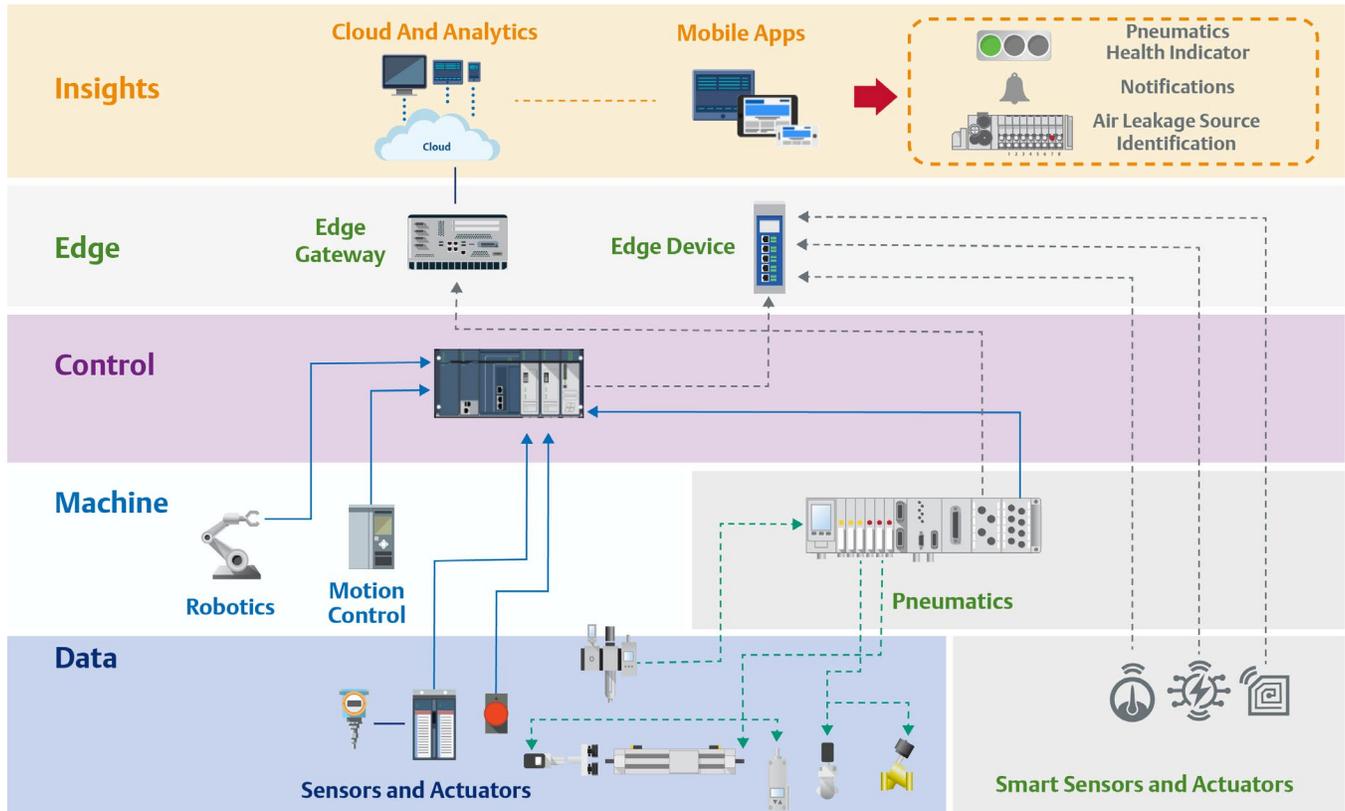


Figure 2.

If You Already Use PLC/PACs, Do You Need Edge Technology?

Yes. No matter what type of control system is used, in order for users to gain access to the isolated data, the system requires edge technology. Edge technology not only allows data from isolated elements to be accessed, it also gathers data from other business/internet constructs and consolidates the information. Equally important, edge technology allows better analytics to be run at the plant level to help give meaning to the data collected. So regardless of the user's control system, edge technology is needed to make the system smarter. But which type of technology to choose is based upon system architecture and goals.

Edge Gateways, Edge Devices and Edge Controllers

The primary types of edge technologies are edge gateways, edge devices, and the new edge controllers that integrate PLC/PAC and edge functions into a single box (see Figures 2 and 3).

Edge gateways would likely be sufficient if your application requires the collection of data at the machine and then offloads that data to the cloud or other higher-level computing systems for processing. Users need to do research, however, to be sure they're not using an edge gateway where an edge device with the advantage of local processing would significantly



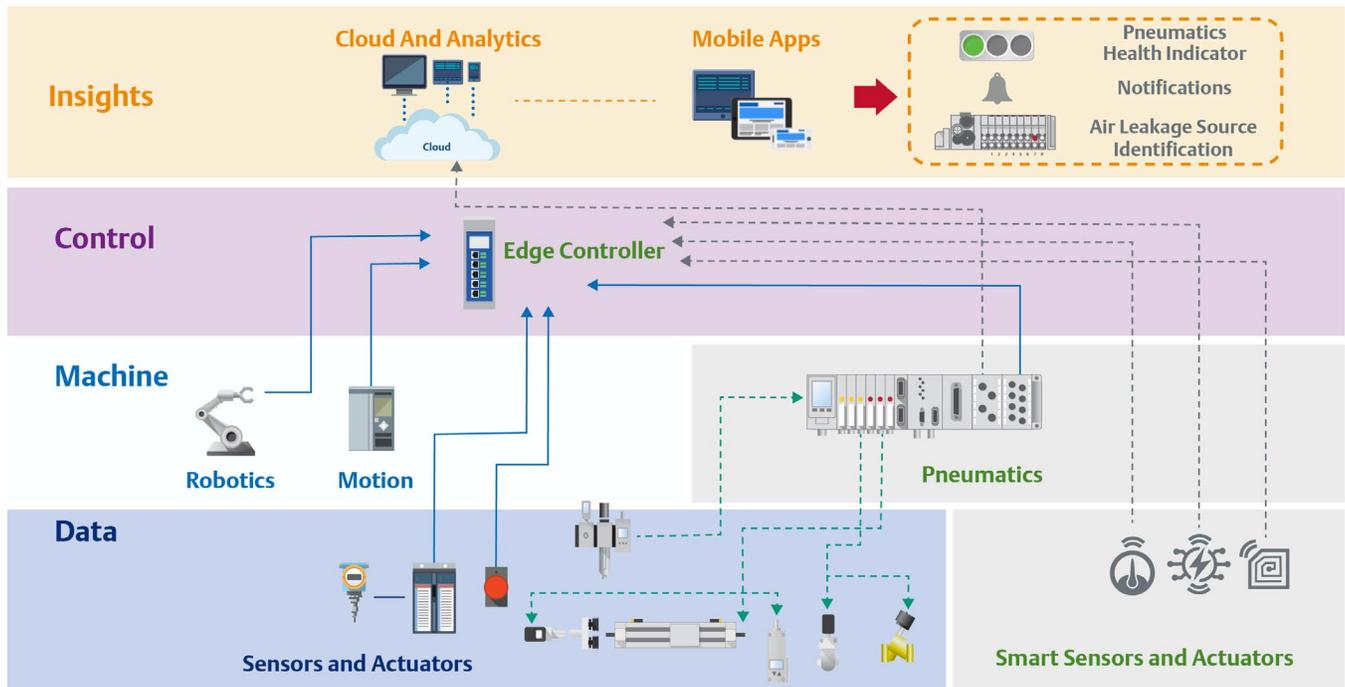


Figure 3.

reduce latency, improve security, reduce cloud storage costs, and enhance real-time decision-making.

Edge devices allow processing at the machine level. The device is integrated with the current control system, consolidates additional IoT data from available sensors and smart devices, and is the choice in existing brownfield plants that don't want to change control systems.

Edge controllers integrate both PLC/PAC control and edge processing into a single system. Edge controllers offer a generational advancement to PLC- and PAC-based industrial control systems by enabling safe, secure communication between real-time deterministic control, and non-deterministic applications that leverage external data to analyze and optimize business operations. Edge controllers provide software-defined

controls with enhanced optimization capabilities, while maintaining the stringent reliability, safety, and security required in industrial applications. The integration of control functions and edge processing makes edge controllers the obvious choice for greenfield projects. In addition, because of the controller's other benefits, existing plants may want to evaluate an edge controller before choosing another edge device.

Advantages of Edge Control Technology

True edge control technology is innovative and new, but is an evolutionary, rather than a revolutionary, development. While offering significant advantages, it's easy to integrate with a plant's existing systems. Users need to be aware of edge control characteristics and benefits, so they don't get older edge technology



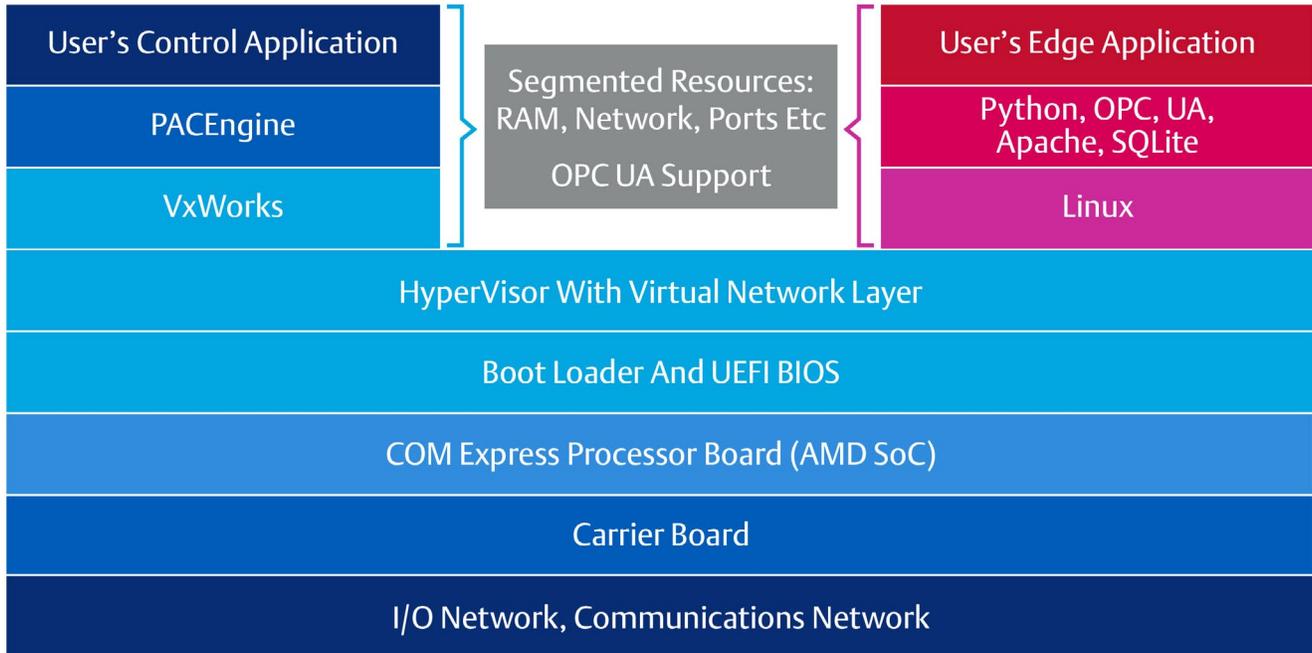


Figure 4.

represented as edge control. Here are some of the capabilities of a true edge controller:

Multiple operating systems in a single box

Key to the ability to process at the edge while providing control functions is the edge controller's integration of multiple operating systems in a single system. Enhanced non-deterministic edge processing runs on a general-purpose operating system (OS) such as Linux, in parallel with a real-time operating system (RTOS) used for deterministic control. Both systems operate on the same physical hardware. The real-time system can optimize equipment control by leveraging data and analytics supplied by the general-purpose system. The general-purpose system can also work in conjunction with external data sources such as enterprise, financial, environmental, and other databases via the internet. Communication between the real-time and non-real-time systems must be highly secure to ensure that the integrity of the real-time control

system is maintained. Users need to evaluate carefully to be sure the edge controller being considered has this multi-operating system capability. Both OSs need to work in a safe and cooperative manner, meaning if the general OS fails or crashes it should have no impact on the RTOS. Likewise, there is no way the applications running on the general-purpose OS can impact the determinism on the RTOS side.

Based on hypervisor technology

The technology behind a true edge controller includes a multi-core processor layered with a bare-metal hypervisor. Through the hypervisor, the multi-core hardware is managed to provide the experience of two independent controllers with a secure communication link between them. This cooperative framework allows near-real-time analytics to run in parallel with real-time deterministic control processes (see Figure 4). The ability to run the two operating systems (an RTOS such as VxWorks and a general-purpose OS such as Linux) in tandem is an entirely



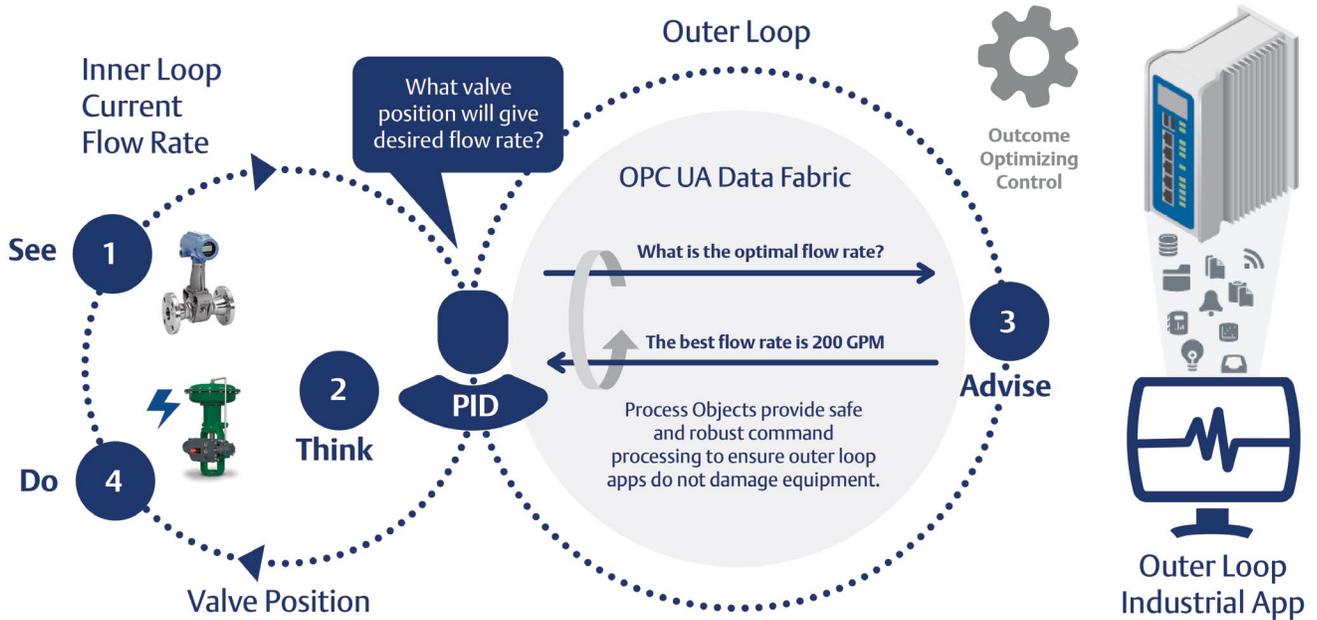


Figure 5.

new approach to the optimization of control processes. Hypervisor technology makes it possible to run analytics and optimization applications at the machine level without directly impacting deterministic, real-time control, assuring new levels of reliability and security.

Modern programming languages simplify analytics

Today with current PACs, users are accustomed to creating rudimentary analytics using IEC 61131-3 languages. In contrast, advanced edge controllers can host modern programming languages, including C/C++, Java and Python, on the general-purpose OS, while supporting standard IEC 61131 languages and C on the RTOS. These and other advanced languages can be used to apply complex optimization algorithms or analytics to operations without affecting the control process. This enables the use of an “outer loop” layer in an application that

can “advise” the typical “see-think-do” control loop, optimizing the real-time control application. In case there is a disruption of some type in this outer loop, the real-time deterministic control is not affected and continues to provide the same functionality as a traditional PAC. See Figure 4 and Figure 5.

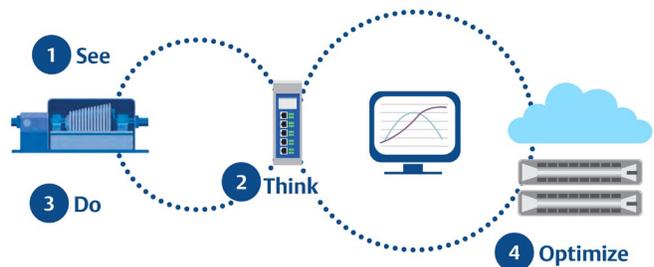


Figure 6.



Providing rapid startup

The key advantage of edge technology is that it makes possible the collection of vital data from industrial assets whether or not this data resides in traditional PLC/PAC controllers. Traditionally, people have had to open the control logic and integrate this additional data into the PLC – an expensive and potentially disruptive step. The benefit of the edge controller is this additional data is available without modifying the PLC logic. This helps users start getting a holistic system view into the optimization apps without having to engage the original OEM to modify the machine logic. The data collected on the edge must be cleaned and normalized into a similar structure, which simplifies app development. OPC UA (Unified Architecture) has emerged as the preferred approach for data representation as it is open, secure, and structured. Emerson has specifically addressed this issue with its PACEdge Software Stack, a vendor-agnostic software designed to perform this cleaning and normalization process automatically, thus allowing apps to be created more rapidly and with better outcomes.

Rugged design

Edge controllers are, by definition, at the machine level, which greatly increases the harshness of the environment. Edge devices must be rugged enough to withstand high heat, variances in air quality, and vibration – with no compromise of performance. Users should choose UL-certified devices that have been designed to work at the machine level.

Heat is a particular challenge. Edge controllers and devices require a standard operating range of -20° to 60° C. Many so-called edge devices de-rate processor performance when they cross 50oC since they aren't created for harsh environments. This slows down operation, which is unacceptable for high-performance devices that must operate effectively at the machine level. Instead, look for heat transfer technology built into the edge controller that will maintain full performance throughout the entire

temperature range.

Security

One of the keys to the data security of edge controllers is the use of the OPC UA protocol. OPC UA is a secure, platform-independent, scalable, and object-oriented architecture for representing and communicating information. By using OPC UA, information can be modeled so that an application can inherently derive its meaning and consequently make better decisions based on that meaning. This enables applications to gain intelligence that can lead to new and exciting outcomes in data management. In addition, OPC UA provides a mechanism to protect the confidentiality and integrity of information and to determine whether applications are trustworthy – a fundamental need of the industrial internet. OPC UA allows contextualization of data for better analytics. Learn more about OPC UA.

Putting Edge Control to Work in Your Systems

What can edge control do for industrial enterprises that they're not able to do now? Here are a few examples:

Remote Monitoring of Control System Health

Big industrial firms, and OEMs with large fleets or numerous remote assets, find it very difficult today to assess the health of their fleet, equipment and plants. While large supervisory control and data acquisition (SCADA) systems usually provide alerts for operational alarms and events, it can be quite challenging to actually debug and diagnose issues in the field, especially in remote areas.

Incorporating edge computing concepts with a PAC makes it possible to monitor and diagnose a fleet of control systems remotely using cloud-based services, all configured in a secure manner. Access to detailed fault logs, hardware, and firmware versions enables operators to debug faults remotely, reducing operational costs and unplanned



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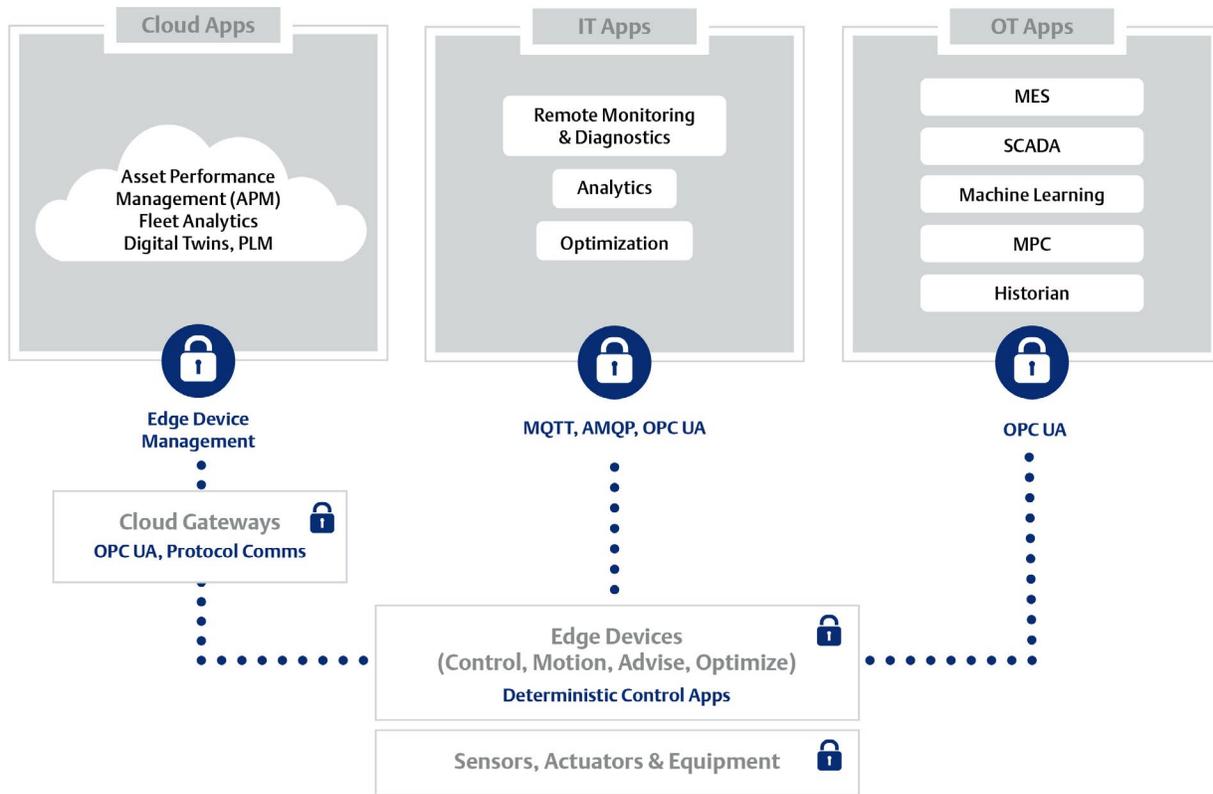


Figure 7. Cloud application

downtime. It is even possible to update control systems remotely in a secure manner to fix faults, with no on-site time required.

Achieve a New Level of Business Automation
Edge controllers facilitate the integration of a wide range of different devices and equipment by using business automation tools and standard IT communications protocols, making it possible to achieve a new level of business automation (Figure 7). Highly efficient maintenance and supply schedules can easily be set up, with notifications sent directly from the device to third-party suppliers and contractors. It's also now possible to connect to IT, OT, and cloud infrastructure directly from the control system to flatten the architecture and enable new levels of efficiency.

Gain New Productivity with Predictive Analytics
Using an edge controller, it's possible to gain a much higher level of efficiency and productivity by running predictive analytics on operational data, and then using the results of this analysis to proactively optimize control actions. This process is akin to traditional process feedforward control where process variables are used to anticipate changes so the system can respond to the process before an error occurs, increasing efficiency. For example, automatically tuning PID loops with great precision reduces time for setup and loop adjustments. Edge controllers provide the interface between the predictive diagnostics applications and real-time control facilitating the feedback loop which allows advanced analytics to dynamically improve process operations in a safe and secure manner.



Integrate Voice Assisted Human-Machine Interface (HMI)

Voice assistants are increasingly gaining adoption in the consumer space, and edge controls provide a secure strategy to incorporate voice assistance into HMIs. Using a third-party IoT kit such as Amazon's AWS IoT Greengrass, edge controllers can be integrated quite easily with voice assistants such as Amazon Alexa. This kind of technology can be used alongside HMI visualization systems in a secure manner, providing productivity gains in industrial settings by reducing training and troubleshooting time.

Edge Technology Achieves Business Outcomes – Emerson Use Cases

To appreciate how users, OEMs and systems integrators are putting edge technology to work in complex applications all over the world, here are a few sample cases.

Wastewater/Water Management –

To increase the efficiency of its operations, a wastewater treatment facility is using an edge controller solution to automate the chemical feed process with edge control taking care of calculating requirements and operating the feed to adjust the amount of chemicals according to the characteristics of the wastewater. By taking advantage of the connectivity provided by the edge controller solution, chemicals are automatically ordered when supplies are running low, without any required operator intervention. Using predictive software at the controller helps operators identify approaching peak periods and automatically organize the supply of chemicals and equipment maintenance to maximize efficiency and cut costs.

For water management in an agricultural application, a system integrator created an application allowing farmers to operate water pumps based upon information such as the

remaining amount of allocated energy, current energy prices and pump operation. This enables operators to shift production between pumps to manage energy costs, all from their smartphones, saving up to \$11,000 a month.

Oil and Gas –

An oil and gas company has used an edge controller solution to quickly identify and resolve problems to maximize system uptime. The edge controller monitors automation fault reports, and automatically dispatches a video drone to the target areas when they occur. Maintenance workers reviewing the video are able to improve their root-cause analysis of the trouble before journeying to the area for repair. The drones can even be commanded to escort maintenance workers to the specific repair area, further reducing repair time.

Infrastructure –

A system integrator in China created an edge-controlled remote monitoring application that connects to the private cloud of a highway tunnel authority. Using this application, they remotely monitor and diagnose control system faults in the remote highway tunnel, drastically reducing operational costs. The ability of the edge controller to collect data from disparate systems has allowed the integrator to incorporate data from devices such as video cameras and lighting systems along with more traditional machines into a single, cohesive dashboard, giving operators a complete picture of operations for the first time and allowing much faster response.

Real Edge Technology

Emerson leads the world in development and innovation of edge technology. The Emerson PACEdge controller is the standard of the industry. It employs hypervisor technology to operate two virtual machines (VMs), rigorously segregating resources such as processors and communication ports at the hardware level. This ensures both VMs operate completely independently with optimum





Figure 8.

performance, all in a safe, secure, and cooperative manner. [Learn more information about PACEdge.](#)

At the same time, Emerson offers the most complete line of edge gateways, devices and control products. Emerson experts can advise on precisely the type of device and

performance-level required for your business to reach a new standard of organizational and operational efficiency.

More information on [PACEdge](#), [PACEngine](#), and edge technology can be found on www.Emerson.com/Industrial-Automation-Controls.

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