Four Key Standards in Machine Automation

KINGSTAR

Introduction

Standards play a vital role in ensuring the safety, functionality, and interoperability of automated machines and systems across various industries, from manufacturing to automotive to test & measurement and to process control. Compliance with these standards increases quality, ensures reliable operation, and facilitates interoperability of machine automation and technologies.

Embracing standards also allow companies to reduce costs and to protect investments.

Companies can achieve cost reductions through several means. First, standards ensures access to well-trained hires from the labor market. Training courses become more prevalent with increased standard adoption. Second, as standards proliferate, supplier competition intensifies, resulting in improved pricing, quality, and service. Utilizing standards fosters a diverse supplier base, guaranteeing a consistent supply, even in cases of shortages or when multiple hardware and software providers are needed. By adhering to standards, companies gain the flexibility to select the most suitable hardware and software from different suppliers and seamlessly integrate them. Finally, standardized components can be repurposed across different systems thus, enhancing cost-effectiveness and efficiency.

Standards protect a company's investment in multiple ways. If a supplier ceases operations, or encounters delivery challenges due to shortages, viable alternatives can be identified with ease. Recent shortages have demonstrated that organizations that adopt open standards are better positioned to source alternative solutions for machine construction. In scenarios where a developer departs from a company or experiences prolonged absence, the process of finding a replacement becomes more streamlined when open standards are embraced.

Applying open standards

Before enumerating industry-specific open standards and those within the automation market, it is essential to understand the typical use-cases for where open standards are successfully deployed in a machine.

Interconnect different brands

Frequently, different machine components like I/O, drives, cameras, controllers must be integrated into a single machine and it can be difficult to integrate components built by different companies without standards.

Mix different brands

Machines that process a part also usually need to move it around or move different sensors for tests. The drives and motors that move parts around do not require the same precision as the ones performing the process operations. It is therefore more cost efficient to buy higher-quality drives and I/Os for the machining and lower performance drives for material or tool changing movement.

Choose multiple suppliers

With inflation and supply chain disruptions, it is important to be able to compare or change suppliers quickly. But this may require changing the brands or models of some of the devices, which should still be able to communicate with the rest of the machine.

Have program portability

There may be many versions of a machine or parts of the machine if it is built modularly (White paper: How to build a Modular Machine). The program controlling a module should support the different versions of that module, which means different hardware and software environments.

Standards are everywhere

Standards are useful at all levels of a total machine automation stack- starting at the hardware and working up the stack to the actual application.

Hardware: CPU/cables/plugs

Standards exist at all levels from:

- plugs for power and Ethernet
- wires like IO-Link or fiber optics
- device sizes like rack and computer boards
- components like RAM and motor shafts

Languages

- CPU: ARM, x86, AMD64
- Programs: C&C++, .NET, Java, Python
- Automation: PLC

Communication

- General public: Ethernet TCP/IP, HTTP
- Industrial: EtherCAT, PROFINET, CC-Link
- IT: OPC UA, MQTT, SQL

Application architecture

Modular programs:

- Hardware abstraction layer
- Communication protocol abstraction
- Kernel with task components

Control commands

- CAN in Automation profiles
- PLCopen
- SRCI (Standard Robot Command Interface to PLCs)
- ROS (Robot Operating System)

Levels of compatibility

Open standards must allow companies to replace hardware or software parts. There are different levels of compatibility. The question becomes “How easy is it to switch a part?” Below is highlight of what to consider.

Concept compatible

- Hardware:

Same number of cables and devices but size and connectors need to be changed.

- Software:

Same program architecture and command set but programs need to be re-written.

Source compatible

- Hardware:

The hardware can be replaced by adding adaptors.

- Software:

The program can be used with no change by linking to different libraries that present the same APIs.

Fully compatible

- Hardware:

The hardware can be replaced and can use the same connectors and space.

- Software:

The program can be used with no change, just copying on the new system.

To achieve the most open applications stack means the focus should be able to achieve full compatibility so components can be swapped out easily. When developing a new system with open standards, this level could be reached most of the time. It means selecting hardware standards for the processing and for the communication, and a software platform for the application development, which has been designed for this purpose.

Four key standards in machine automation

Now, the focus shifts to the automation market and its key, indispensable standards. Adopting standards that are widely accepted is crucial because only widely accepted and utilized standards deliver on the promise of openness, quality, cost reduction and safety. Accepted standards promote interoperability, compatibility, and consistency, fostering collaboration and innovation across the board. In contrast, well-written but poorly adopted standards may remain underutilized, and closed thereby limiting their effectiveness and hindering seamless integration within the industry. In sum, widely accepted standards ensure a level playing field, encourage participation, and provide a common foundation for progress, ultimately benefiting both users and the industry.

The following represent the four most important standards for Machine Automation and Robotics:

1. EtherCAT & OPC UA

They offer source compatibility with hundreds of different brands.

2. CANopen Drives & Motion Control Profile 402

Full compatibility for hundreds of drive control.

3. PLCopen Motion control

Concept compatible for all sorts of drive control.

4. SRCI

Full compatibility for Robot control. New but the number of brands is growing, and some major players are embracing it.

KINGSTAR: Open Standards based machine automation

Many IntervalZero customers have developed their own Machine Automation Platform on RTX64 as you can see in this white paper on How IntervalZero's RTOS platform Transformed Machine Automation In Japan. To help customers, IntervalZero created a similar integration platform known as KINGSTAR. The architecture in KINGSTAR can be used as a guide for how RTX64 can be used to build an Open Machine Automation Platform from the ground up.

When choosing a software development platform for machine automation, companies should opt for an environment that aligns with widely adopted standards to reap benefits like openness, quality, interoperability, and cost-efficiency. KINGSTAR is a good example of a truly open solution because it embraces standards at every level of the solution stack.

The KINGSTAR Machine Automation Software consists of five components:

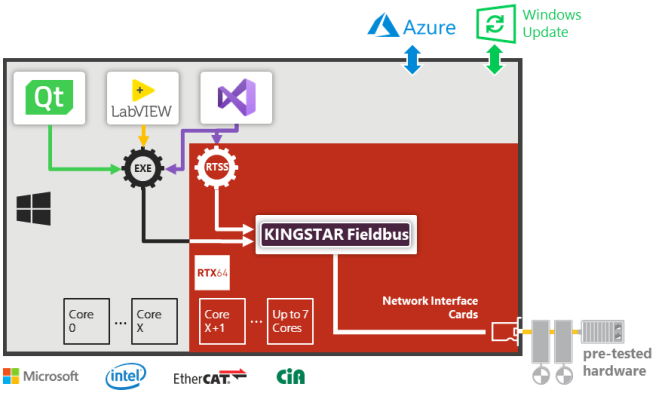
- **KINGSTAR Fieldbus** (real-time EtherCAT® Master)
- **KINGSTAR Motion** (motion control)
- **KINGSTAR PLC** (software Programmable Logic Controller)
- **KINGSTAR Vision** (real-time GigE Vision solution)
- **KINGSTAR IoT** (IoT-enabled platform)

Leveraging the PC Standard

At the foundation, KINGSTAR utilizes the most widely adopted standard: an Industrial PC.

KINGSTAR transforms Windows into a real-time operating system. Windows is another standard that delivers powerful interoperability, quality and stability.

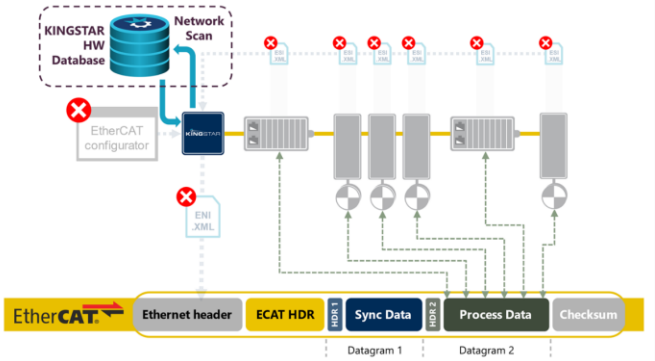
Running with 64-bit Windows 10 or 11, RTX64 allows real- time applications to be developed with C & C++ in Visual Studio. It can be used on a wide range of general-purpose computers, and is deployed in many different industries, such as automation and robotics, but also medical, defense and simulators.



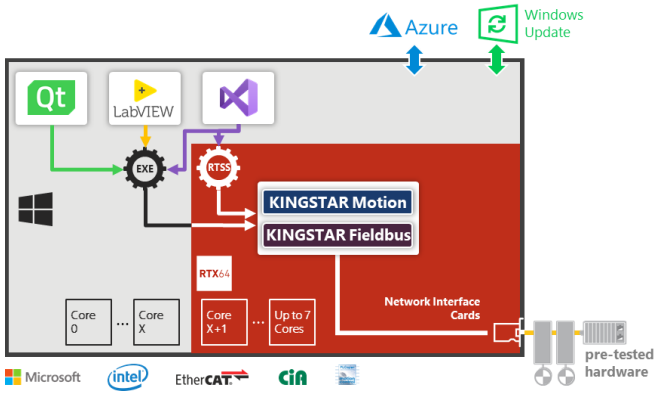
KINGSTAR Fieldbus architecture

Utilizing the EtherCAT Standard with Auto-configuration

KINGSTAR fieldbus implements a Plug & Play EtherCAT® stack on RTX64. As mentioned in a white paper entitled 5 Real-Time, Ethernet-Based Fieldbuses Compared, IntervalZero believes EtherCAT® is the best protocol for machine automation, and the KINGSTAR product is based on it. To provide more flexibility to applications, IntervalZero took advantage of the EtherCAT® bus scan capabilities, to build an automatic configuration feature, which allows the same application to run with different hardware configurations. The main benefit of this automatic configuration is the support of all the major servo-drive and I/O hardware brands, and users can add support for new EtherCAT-based hardware without updating KINGSTAR. In addition, the fieldbus layer provides direct access to variables, as if they were local, completely hiding the fieldbus from applications.



KINGSTAR Fieldbus Automatic configuration feature



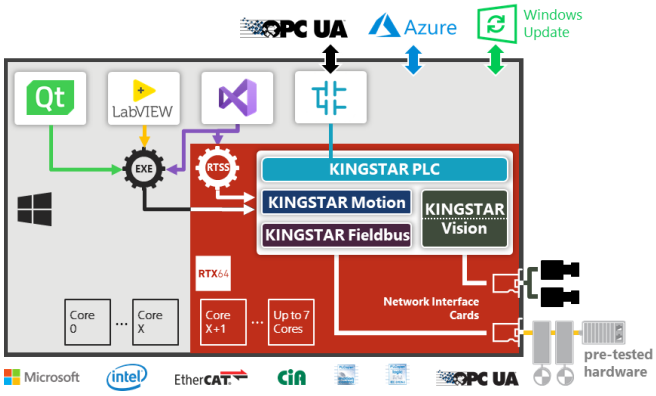
KINGSTAR Motion architecture

Standards Benefit: EtherCAT, CAN DS402, PLCopen, OPC UA

To further round out the platform for smart machine control, KINGSTAR also provides a software motion component. KINGSTAR Motion complies with the PLCopen Motion Control standard specifications for point to point, synchronized, group motion, blending and kinematics. With modern processors and the optimized motion equations in KINGSTAR, it is possible to control a large number of axes at fast cycle times. For example, applications can use 20 axes with 125µs cycle time or 60 axes with 500µs cycle time. Each axis can use a different brand of hardware and have its own control mode. Communication with the drives is based on cyclic synchronous modes, the interpolation is done in the controller, but the PID can be either in the controller or in the drive. The motion algorithms allow modifications of the motion profile while the axis is moving. The synchronization supports electronic camming, gearing and group motion with linear, circular and helical moves. These KINGSTAR Motion features are very flexible as a CAM or gear master axis can have multiple slaves, and itself be a virtual axis or even the slave of another axis. These motion features are available to both real-time and Windows applications.

The third component is KINGSTAR PLC which provides a fully-featured and integrated software PLC based PLCopen standard and accessible RTOS standard – RTX64 from IntervalZero. KINGSTAR PLC also includes add-on or third-party components for motion control and machine vision that are managed by a rich user interface for C++ programmers and non-developers alike.

KINGSTAR Vision is a real-time GigE Vision® stack, which allows customers to develop vision-directed motion control using OpenCV standard on a Windows PC. KINGSTAR Vision is a comprehensive collection of software tools for developing machine vision, image analysis and medical imaging software applications on GigE Vision® and many other camera interfaces. It includes tools for every step in the process, from application feasibility, to prototyping, through to development and ultimately deployment.



KINGSTAR PLC with KINGSTAR Vision architecture

Finally, KINGSTAR IoT for Windows PC adds IoT functionality to machine control by capitalizing on the most open machine automation software platform and the OPC UA standard. For more information on this topic, several white papers are available on the www.kingstar.com website. Importantly, the whitepaper Achieving Industry 4.0: Four Critical Features for Smart Machine Automation presents an in-depth analyses of this topic.

Conclusion

Embracing Open Standards offers compelling advantages for OEMs and Machine builders. Foremost, it leads to substantial cost reduction and safeguards company investments. In the realm of industrial automation, countless standards exist, from established ones like EtherCAT to emerging ones like SRCI for robot control. To fully harness these standards, it is imperative to have a software platform that not only supports existing standards but also stands ready to embrace new emerging ones. KINGSTAR is precisely that software platform, offering a comprehensive solution for seamless standard integration and future adaptability.