TwinCAT Communications maximizes performance and openness

An open control system such as TwinCAT primarily consists of core functions that make up the actual controls. These include the real-time system as the foundation, the PLC as the programming platform for the system developer, motion control and many other functions. Just as important, however, is the control system's ability to communicate, which is what makes the control functions usable and, above all, ensures the expandability of a specific application.

Initially, TwinCAT focused on two types of communication that enabled the basic functions of the PC-based software: cyclic I/O communication and acyclic demand data communication. Further communication channels were added later to integrate the control system within a production line, the factory and also the cloud.

Cyclic and acyclic communication

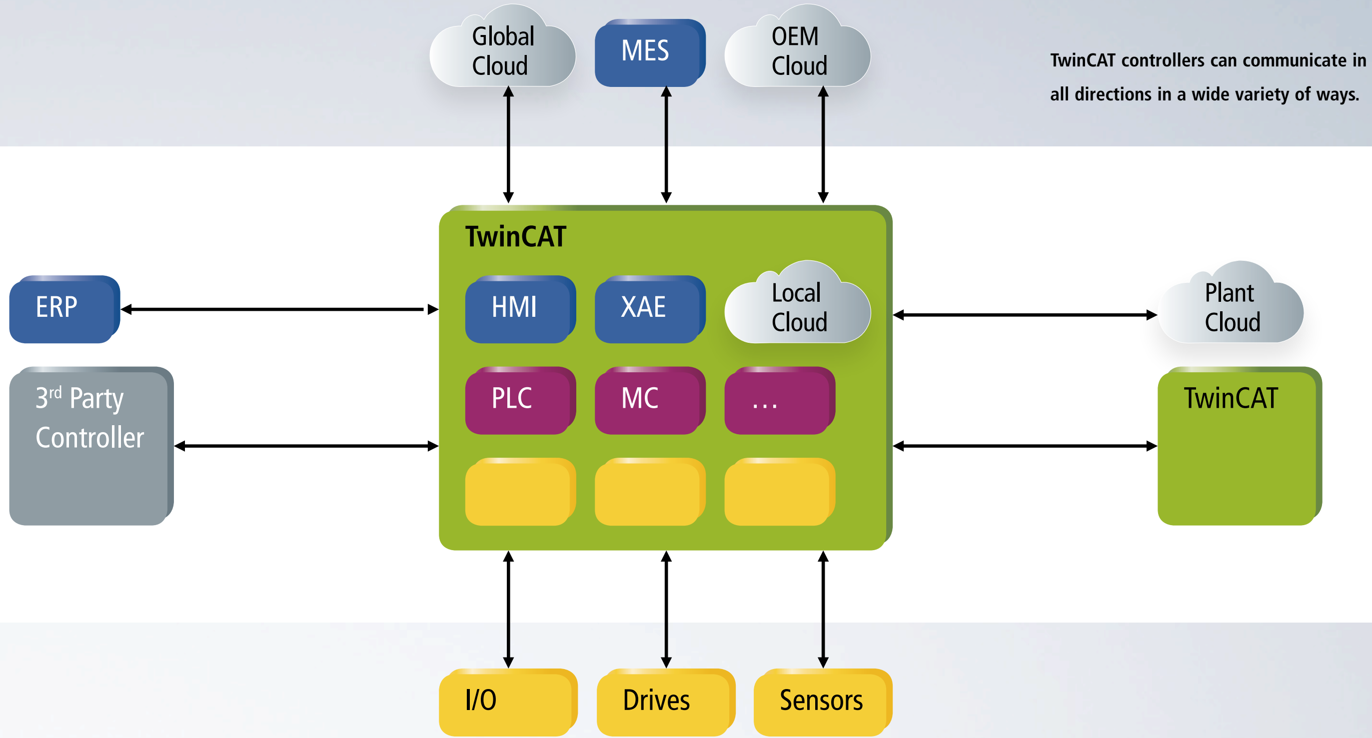
In contrast to many other control systems that access the connected I/O devices directly from the PLC, TwinCAT relies on the more abstract model of process images for cyclic communication. Each functional unit that cyclically exchanges I/O data has a logical process image that contains its corresponding variables – regardless of the actual destination of the data. Only linking the variables (e.g. a PLC variable with the I/O variable of a fieldbus) can define the relationship for a specific application. Then the system calculates the resulting copy actions between the process images – the so-called mapping. This special communication technology enables the application logic to be developed independently of the actual hardware used and offers users the necessary flexibility – especially in the case of series machine building.

The individual functional units of a control system also exchange demand data that can trigger certain events or read out and display states. As part of this acyclic communication, for example, the PLC triggers the start of an axis during motion control, a parameter of a fieldbus device is changed or certain PLC variables are displayed on the user interface. Here, too, the introduction of a general and continuous form of communication – the Automation Device Specification (ADS) – has laid the foundation for flexible and expandable data exchange. Every logical and real functional unit inside and outside the controller, e.g. in intelligent fieldbus components, is part of the ADS network and can be reached via uniform addressing and a few defined services. ADS routers distribute the messages so that they reach their destination as quickly as possible – regardless of whether it is purely software communication within the controller or messages sent to other controllers or operating devices via fieldbuses or TCP/IP.

In the field of control communication, a wide variety of standards have evolved over time – and they continue to evolve. The abstraction of the I/O and ADS communication in TwinCAT makes it possible to easily create corresponding gateways and implement the native procedures of the respective standards. These gateways can be implemented as a pure software solution or with hardware support. Currently, gateways are available for almost all relevant communication standards in the control environment. Users can create their control programs independently and only then have to define the specific communication paths and standards used by configuring them appropriately.

Cloud communication

In recent years, the connection of the controller to systems that are not directly located in the customer enterprise network has continued to gain importance. With cloud communication, for example, digital twins can be integrated, which reflect the system status, or enable system access from outside. Additionally, common cloud servers can be used to evaluate control data, among other things, in order to carry out predictive maintenance or optimizations. In this area, communication standards from the control environment (e.g. OPC UA) compete with those that are common in the general IT world (e.g. MQTT and JSON). What both have in common is that security topics are much more in the foreground than in the direct machine environment, such as authentication, assignment of rights and encryption.



TwinCAT controllers can communicate in all directions in a wide variety of ways.

However, cyclic and acyclic control-related communication can also be used sensibly in the cloud environment. Specially compiled process images that include cycle-synchronous information directly from the controller enable detailed analysis and can efficiently provide training data for machine learning systems. In the area of demand data, data exchange via IT standards is in many cases preferable to those of the more specialized automation methods, since it is then possible to communicate natively with the general services of the cloud provider. Then, however, this requires a corresponding implementation in the controller or an upstream device (e.g. an edge device). ADS over MQTT, which was introduced a few years ago, makes it very easy to use ADS communication in the cloud to access more specific data and functions from the cloud. Among other things, this enables a direct connection between a controller (runtime) located anywhere in the world and a local engineering system – without complicated VPN connections to the respective operator network.

MQTT, as a lean communication protocol, uses data intermediaries – called brokers – to transport the data packets. General authentication and encryption mechanisms commonly used in IT are available to enable secure connections worldwide. Broker-to-broker communication can also be used to route the data stream in such a way that, on the one hand, configuration is facilitated, and, on the other, the actual data can also be monitored by the plant operator. For example, an intelligent field device can send diagnostic data to the manufacturer of the device via the system operator's broker so that he or she can examine the data in unencrypted form and then forward it in encrypted form.

Overall, the communication requirements for modern controls are very diverse. They range from highly synchronous, fast process data communication to cloud communication with standard IT servers. PC-based control systems have a clear advantage here, as they have the necessary Ethernet interfaces and can easily integrate other fieldbuses via EtherCAT gateways. Within the factory or in the cloud, IT standards are available that enable safe and efficient controller integration with general IT and make advanced services available.

Dr. Dirk Janssen, Head of Software Development

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ADS: www.beckhoff.com/tc1000
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