Connectivity: from sensors to the IT cloud

The application of PC-based control technology is an undeniable success story. The benefits of the scalable, extendable PC platform have been described in many facets, such as high-performance, adaptable CPU cores and numerous PLC, Motion and Scientific Automation software functionalities. Connectivity is another important aspect of PC Control that has advanced significantly over the years. This article, therefore, focuses on integration with visualization solutions, master computers, databases and other third party-applications rather than the real-time capable fieldbus level.

History

In 1993 Beckhoff introduced the S2000 controller, a Microsoft-DOS-based control system that was real-time capable through pure software extensions. It also enabled the processing of PLC, Motion and visualization on a single CPU. Even then "external" communication from this system was possible via TCP: The application of the RK3964 protocol between master computers and machine controllers was the de-facto standard. Information exchange was also possible via databases or the actual file system: Information about the machine status and process was exchanged with the outside world through cyclic testing of changes in the database or the presence of special files. Before the implementation and coding, the developers invariably coordinated the configuration of the data structures to be exchanged (e.g. the allocation list in the data blocks) by phone or fax. Any modification necessitated retrospective adaptation of the applications. Even though this kind of effort raises a smile today, at the time the communication options of the S2000 were unsurpassed by other control systems.

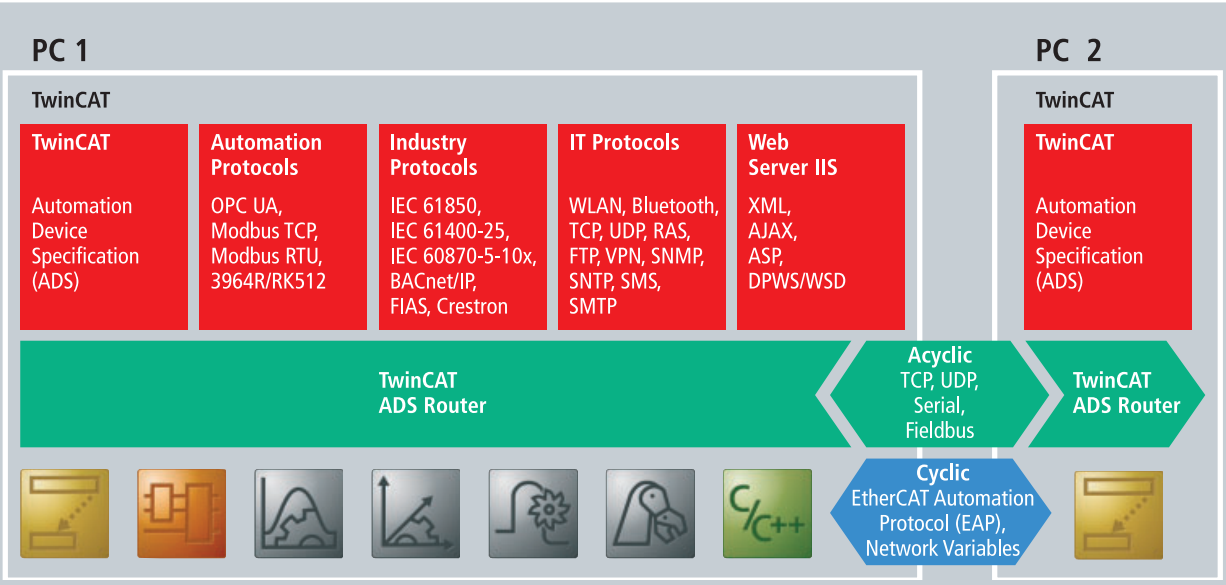

Fig. 1: Two connection categories are available for cyclic exchange between two TwinCAT control PCs: For acyclic communication ADS can be used as routing-capable protocol. The EtherCAT Automation Protocol (EAP) offers significantly higher performance: Via a publisher/subscriber mechanism, process data can be exchanged between EtherCAT masters in the cyclically ms or even µs range.

Status

Today's TwinCAT system offers almost universal connectivity, based on the ADS (Automation Device Specification) standard defined by Beckhoff: A message-based, routing-capable transport layer designed for performance, which is used both vertically (between the Windows applications and real-time applications in the kernel) and horizontally (in the network to other applications, such as visualizations). ADS is available free of charge for Windows environments. Many visualization providers implement it directly in their systems in the form of drivers. In line with the openness of ADS, the structure is documented and can also be implemented for other, non-Microsoft operating systems. Many supplementary products were developed with an ADS framework based on the principle of a "protocol converter" that is also available to customers: For example, the TwinCAT FTP Client provides access as a converter via ADS from the PLC to international FTP commands, enabling FTP file transfer from the PLC controller.

However, TwinCAT not only utilizes IT-based protocol options such as FTP, VPN, web pages or sending of e-mails or text messages from the PLC controller, the general automation protocols such as the good old 3964 or Modbus are also available. Since 1996 OPC DA has become a globally successful interoperability initiative: The COM/DCOM-based Microsoft technology has contributed to rapid dissemination of visualization systems.

Beckhoff recognized the technological advantage of the OPC successor, Unified Architecture (OPC UA), at an early stage and implemented the TCP/HTTP-based standard right down into the smallest Embedded Controllers. This standard, which adheres to all international safety aspects, enables direct connection from small CX80xx Embedded Controllers beyond the HMI into the MES/ERP layer and directly into the SAP system. For many areas such as Building Automation, wind energy and others, industry-specific protocols were developed over the years with the aim of rapidly establishing Beckhoff components in these markets.

Two connection categories are available for cyclic exchange between two TwinCAT control PCs (Fig. 1): For acyclic communication, ADS can be used as a routing-capable protocol. Data are sent via the regular network stack of the operating system and are subject to the rules of the general network load. As a result, a connection can exchange data in the low millisecond (ms) range. The EtherCAT Automation Protocol (EAP) offers significantly higher performance: Via a publisher/subscriber mechanism process data can be exchanged cyclically between EtherCAT masters in the ms or even microsecond (µs) range.

Future

Predictions for future connectivity options aren't just vague crystal ball gazing: Developments, committee work and cooperation between associations take place as we speak, but it will take a couple of years before they become visible for companies and therefore the general public as products in the market:

The EtherCAT Automation Protocol (EAP) will not only be used for faster, horizontal exchange between EtherCAT masters, but also by visualization applications that specialize on high data volume, e.g. in measurement technology. EtherCAT thus grows from a pure "device protocol," as a real-time fieldbus at the lowest level, into an "automation protocol" (EAP) for machine networking, including the HMI. As the higher-level transport layer, OPC UA could ideally make the EAP information model available for configuration, but also for data transfer right into the MES/ERP layer.

Stefan Hoppe, TwinCAT Product Manager, Beckhoff Automation

On the other hand, OPC UA will also penetrate from the current scenario in the future (which is "from the controller up into the Enterprise ERP layer"), down into the field level: The focus is not on the real-time capable, deterministic fieldbus. There are numerous field devices that simply have to be "fast" and accessible for process data or for configuration via UA authentication and encryption via TCP. Different suppliers like Siemens and Endress + Hausser have publicly announced UA down to the field level.

In addition to the already existing, interoperable access to controllers, collaboration between PLCopen and the OPC Foundation will result in standardized PLC function blocks for UA communication from the IEC 61131-3 controller. For Beckhoff this is already part of the UA product today. A new MES Connectivity PLCopen working group will define a standard access from MES systems to PLC control level in collaboration with the OPC Foundation and other committees and associations working on MES.

The Beckhoff ADS components now not only support x64 operating system platforms and multi-core CPUs, but enable convenient integration to suit all IT trends: Small embedded TwinCAT control systems with limited local memory can store measured data logged via an ADS data link directly in the "Microsoft Azure Cloud" or solutions of other Cloud providers. These data are then available worldwide for further analysis by other applications. Further industry-specific protocols will be implemented in order to introduce the successful solutions from the Beckhoff automation kit in new markets.

Connectivity remains exciting! With its scalable, PC-based control philosophy and the internal ADS architecture, Beckhoff has an ideal platform for the future.

www.beckhoff.com/TC-ADS
www.beckhoff.com/TC-OPC

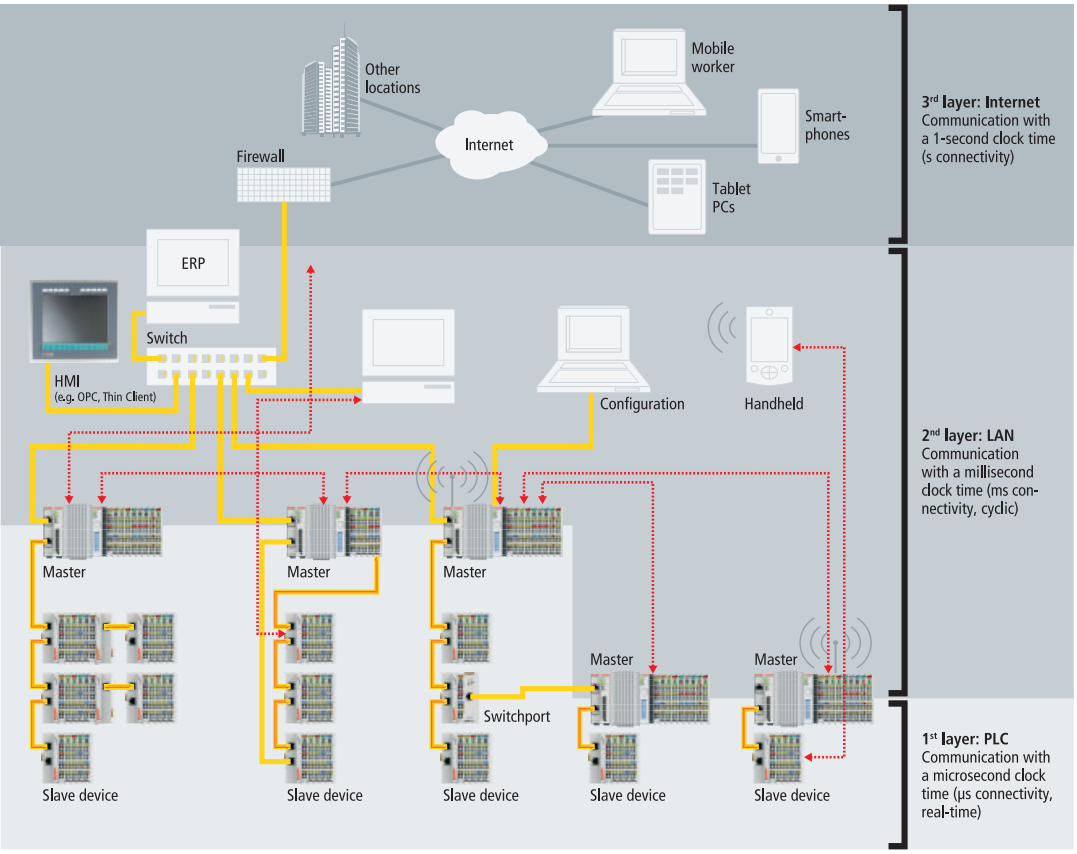

Fig. 2: EtherCAT thus grows into an "automation protocol" (EAP) for the machine networking level. OPC UA will also penetrate down into the field level. With ADS the Beckhoff IPC platform provides a scalable connectivity solution "from sensor into the IT cloud."