XPlanar: the revolution in product transport

22 | interview
Hans Beckhoff in an interview on the milestones in the development of PC-based control technology

28 | worldwide
Empa: Flexible communication across building and mobility applications with OPC UA
news

4 | Trade show previews 2019

5 | Trade show reviews 2018/2019

26 | Personal news

interview

6 | Interview with Uwe Prüßmeier on the new drive system: “flying motion” with free-floating planar movers

22 | Hans Beckhoff in an interview: Looking back on 20 years of PC-based control technology

products

12 | CX7000 Embedded PC: The new entry-level class with 400 MHz processor and integrated multi-functional I/Os

16 | Product news

20 | AMP8620: Drive technology without control cabinets

21 | TwinCAT Scope meets OPC UA
worldwide

28 | Empa, Switzerland:
Flexible communication across building and mobility applications with OPC UA

34 | Fraunhofer IWS, Germany:
Productivity increase for laser material machining applications

38 | Fortna and Journeys, USA:
Distribution center upgrade for footwear retailer

42 | Emirates Team New Zealand, New Zealand:
Industrial control technology proves seaworthiness in harsh sailboat race conditions

46 | Ecmec, Sweden:
TwinCAT 3 controls highly efficient machine for processing of die-cast automotive parts

48 | IMT, France:
3D printing – Making an architect’s dreams come true

ETG

52 | News and activities of the EtherCAT Technology Group

events

54 | Trade shows and Events 2019
At Automotive Testing Expo, Beckhoff will be presenting its highly precise, fast and robust measurement technology. The ideal integration of hardware and software modules provides for an end-to-end measurement chain: from I/O modules for the connection of all common sensors, the EtherCAT measurement fieldbus and various on-premises TwinCAT software modules to data processing in the cloud.

At Ligna, Beckhoff will demonstrate the many advantages of an integrated control system for woodworking machines: With PC-based control, machine builders benefit from an end-to-end tool chain for PLC, motion control, HMI, safety, image processing and IoT. This means that with the integrated hardware and software platform, all machine functions as well as upstream and downstream production processes can be connected. With TwinCAT IoT, standardised interfaces and support for protocols such as OPC UA, Beckhoff offers the ideal foundation for implementing IoT and Industrie 4.0 concepts.

With an extensive portfolio of high-end measurement modules in various performance classes, the EtherCAT measurement technology fieldbus and TwinCAT software modules, Beckhoff will present system-integrated measurement technology solutions for test benches and industry at Sensor + Test. Apart from the integration of vision systems, cloud connectivity and data analysis are also part of the overall control system: it allows for the centralised correlation of all acquired measurement data in networks or cloud systems.
Trade show reviews 2018/2019

SPS IPC Drives

ISE

Trade Show TV: www.beckhoff.com/ise

LogiMat

Trade Show TV: www.beckhoff.com/logimat
Interview with Uwe Prüßmeier on the new drive system: "flying motion" with free-floating planar movers

XPlanar: Maximum positioning flexibility with six degrees of freedom

With planar movers that float freely positionable over floors of planar tiles that can be arranged in any kind of pattern, the ground-breaking XPlanar system from Beckhoff offers boundless potential for streamlining production machine and plant design. In this interview, Uwe Prüßmeier, Senior Product Manager Drive Technology, discusses the unique value proposition of a system that can position movers precisely, dynamically and with exceptional flexibility.
Flying motion: XPlanar is a contact- and wear-free solution for the transportation of products.

With the XPlanar system, planar movers float freely over planar tiles that can be arranged in any layout.
What characterizes the new XPlanar drive system based on the principle of flying motion?

Uwe Prüßmeier: Like the XTS linear transport system, XPlanar is much more than just a drive system – it’s a comprehensive solution designed to make product transport extremely flexible. Compared to XTS, XPlanar adds movement in a second dimension and allows the movers floating over floor tiles to overtake one another, and to be held in buffer zones or to bypass them. The free-floating planar movers also have a further important advantage: because of the contactless drive principle, they are silent and completely wear-free.

What kind of functionality does this system provide for implementing transport tasks?

Uwe Prüßmeier: Basically, a transport system simply moves products from one processing station to the next – from A to B, then from B to C, from C to D, and so on. With XPlanar, these stations need neither to be in a linear arrangement nor visited in a fixed sequence. This means that a given product need only travel to those stations that are essential for processing it. By incorporating the second dimension, XPlanar opens up several other options, too, including the ability to discharge individual movers from the production flow or to create special waiting zones in order to optimize processing sequences. Enabling faster movers to overtake slower movers is also important as it allows sub-processes to be executed swiftly, in parallel. Not only is each planar mover controlled individually, as a single servo axis, it can also be synchronized precisely with other movers if necessary.

The movers can travel with six degrees of freedom. What are the benefits, particularly at processing stations?

Uwe Prüßmeier: The movers not only travel to processing stations, they can also move into them. They can turn, too, rotating the payload they’re carrying through all three axes so that it can be processed or inspected easily from any side. The movers can also be raised or lowered slightly and even tilted. A little tilt, for example, can be useful to prevent spills when accelerating quickly while carrying a container full of liquid.

In spite of all the complex motion options that XPlanar supports, the system is simple to set up and deploy from user standpoint. What are the key factors here?

Uwe Prüßmeier: Right at the start of the development process, we decided it was important that the system should be highly integrated and that users would only have to plug in two cables – one for data communication over EtherCAT G and another for power supply. As a result, all other functionality has been fully incorporated into the modules. Design-wise, they are also extremely compact: The distance between the working surface of each planar tile and the carrier frame beneath it is just 4 cm.

And choosing individual XPlanar components is just as simple?

Uwe Prüßmeier: Yes. The system builds on one basic component, a planar tile measuring 24 x 24 cm. The tiles can be arranged in any floor or track layout. In addition to this standard tile, there will be another version in the future, identical in shape and size, over which planar movers can rotate through a full 360° – that is to say, infinitely. The movers available differ only in terms of their size and therefore their load-carrying capacity. They currently range from 95 x 95 mm, for payloads up to 0.4 kg, through to 275 x 275 mm, for a maximum payload of 6 kg.

The TwinCAT software also plays a key part in the system’s ease of use. What is the primary focus here?

Uwe Prüßmeier: Our main objective is to make sure that users find the planar motor system easy to manage. In TwinCAT, the planar movers appear as simple servo axes, capable, in principle, of supporting all six degrees of freedom. However, given that the degree of flexibility available with six axes is not always needed from a practical perspective – or, at least, not throughout the XPlanar system – TwinCAT provides a way to reduce this complexity. It does this by representing each mover as a one-dimensional axis capable of optional additional movements in other dimensions – lifting, tilting and turning, for instance – that are available when it reaches a processing station. This means it’s enough, initially, to just set the desired route, or track, across the XPlanar floor; this simplifies operation significantly.
How important is TwinCAT Track Management when implementing complex motion sequences?

Uwe Prüßmeier: A key factor in XPlanar’s exceptional flexibility is that its ability to transport products is not confined to the aforementioned single tracks. You can define additional tracks, and movers can switch between them. To keep things simple for users, even when operating multiple tracks, TwinCAT offers Track Management, an extremely user-friendly tool designed to support complex motion sequences, including the ability to overtake slower movers on the same track or to accumulate movers in waiting zones. To do this, it allows users to define parallel lanes, bypasses, or tracks to other plant areas on the XPlanar floor. Track Management lets movers switch smoothly from one track to another via a short parallel segment. All this takes is a “switch track” command, without users having to deal with the specifics of merging in and out of the flow or avoiding collisions. Movers can also be positioned with complete freedom, without having to follow any preset tracks. Using Track Management, they are simply sent to specific coordinates within the defined XPlanar floor space – again, without any risk of colliding with other movers.

From a user’s perspective, what are the advantages of building the XPlanar floor from individual tiles?

Uwe Prüßmeier: Here, too, we put flexibility front and center. The tiles can be arranged in any shape – and even wall- or ceiling-mounted – so the XPlanar system can be configured to perfectly suit a given application’s requirements. For instance, you can leave gaps within the tiled floor to accommodate processing stations or lay tracks around plant components. This means users can set up a transport system in a cost-optimized fashion and, at the same, reduce machine size to a minimum. In addition, it’s easy to modify the planar motor system subsequently, just by adding more tiles when necessary – e.g., to accommodate new processing stations or gain extra space to optimize motion through curves.

How can users best exploit this immense innovation potential?

Uwe Prüßmeier: XPlanar opens up new avenues in machine and system design. Users need, literally, to experience the system’s new possibilities hands-on in order to grasp them, so at market launch we’re offering easy-to-use starter kits, just as we did with XTS. These consist of six or twelve planar tiles installed on a carrier frame, along with four movers and a small control cabinet with an Industrial PC, complete with pre-installed software, and the requisite electrical components. This offers machine builders an ideal basic kit on which to trial XPlanar in their own environments and then go on to use later in real-life applications. In addition, offering this kind of preconfigured system makes it a lot easier for the Beckhoff support staff to answer any questions that might arise.

Which mechanical engineering sectors or use cases does XPlanar suit best?

The immense flexibility of the XPlanar system makes it ideal for a wide range of transport tasks in the most diverse areas of application, including the pharma and food industry.
Uwe Prüßmeier: There are almost no limits on using it with production plants and machines. The only requirement is that a product’s weight and volume are within the limits of what the planar movers can carry. Where this applies, users can benefit from all the system’s highly flexible positioning capabilities. These are particularly interesting in sectors with special requirements in terms of hygiene and cleanability, zero emissions or low noise. This is the case in the food and pharmaceuticals industry as well as in laboratory environments or processes that require a vacuum (in semiconductor production, for instance). The latter two sectors in particular can benefit from the fact that products are carried on floating movers, abrasion- and contamination-free. Depending on the needs of a given application, users can also apply plastic, stainless steel foil or glass plates to the XPlanar surfaces to make them easy to clean without residue.

XPlanar was first exhibited at the SPS IPC Drives show in Nuremberg in November 2018. What kind of feedback have you had from show visitors in response to this innovation?

Uwe Prüßmeier: The exhibit attracted considerable interest among visitors; it also spawned lots of ideas for possible applications, because many users have been looking for a flexible solution to solve specific transport problems in their production facilities for years now. Here’s an example from food processing: In the production of high-quality confectionery, there are always minor deviations in the color of chocolate coatings. This is not a problem as such provided there’s no variance within individual boxes of chocolates. However, at a production rate of 100 chocolates per minute, selecting ten individual chocolates with the same color for each pack is difficult using conventional means. It would require using several pick-and-place robots to check and sort all the chocolates, which would be costly in terms of time, floor space and throughput rate. The problem can be solved much more efficiently using individually controlled planar movers operating on a single floor. Movers transporting individual chocolates could easily sort themselves at the end of the production line according to the chocolates’ particular shade of color. Or, if movers were designed to carry an entire box at once, each mover could automatically travel to the system ejection point for the appropriate color of chocolate to pick up the products. Both of these approaches could be implemented much faster and, importantly, with lower space requirements than, for example, the robot solution I mentioned.

Are there other current examples where the high flexibility of XPlanar is crucial?

Uwe Prüßmeier: We already received specific inquiries from the laboratory automation sector, where there’s considerable interest in maximizing the flexibility of analyses. For the most part, samples are tested for the same substance content, but less common analyses also need to be carried out for the purpose of individualized diagnostics. Even with mass analysis methods, XPlanar offers a great way to extract individual samples; it also creates additional quality assurance advantages by making it easy to discharge or exchange particular
samples. There’s similar demand in the cosmetics industry, too. For example, in one particular case, fragrances need to be filled into selectable, customer-specific bottles that are individually labeled and packaged.

**How do the XPlanar and XTS transport systems differ in terms of use?**

Uwe Prüßmeier: The main difference is that the XPlanar movers don’t need a mechanical guide rail so, as already mentioned, the system offers greater flexibility in terms of movement. At the same time, though, the mechanical guidance in XTS can be an advantage: Compared to the magnetic counterforce of the planar movers, a guide rail allows significantly better dynamics and higher speeds in curves, especially in very tight curves, and even when carrying a payload. The specifics of a given application will ultimately determine which of the two systems is the better option. The bottom line is that XPlanar and XTS complement each other perfectly.

The interview was conducted by Stefan Ziegler, Editorial Management PR, Beckhoff

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**XPlanar: Planar mover technical specifications**

- max. speed: 4 m/s
- max. acceleration: 20 m/s² (without payload)
- four available sizes: 95 x 95 mm, 155 x 155 mm, 155 x 275 mm and 275 x 275 mm
- mover thickness: 12 mm
- max. payload (largest mover): 6 kg (at low speed)
- max. levitation height without payload: 5 mm
- max. levitation height with 1 kg payload: 1 mm
- max. angle of rotation (±): 360°, ±15°
- max. angle of inclination: 5°

Further information: [www.beckhoff.com/xplanar](http://www.beckhoff.com/xplanar)
ARM, 400 MHz

TwinCAT® 3
CX7000 Embedded PC: The new entry-level class with 400 MHz processor and integrated multi-functional I/Os

The CX7000 Embedded PC opens up the convenience and efficiency of the TwinCAT 3 software environment to compact controllers. This further enhances the scalability of PC-based control technology from Beckhoff – ranging from mini-PLCs to many-core Industrial PCs. An advanced 400 MHz processor and built-in configurable I/Os mean the Embedded PC delivers an optimum price/performance ratio.
Equipped with an ARM Cortex™-M7 processor (32 bit, 400 MHz), the CX7000 Embedded PC makes considerably higher processing power available in the low-cost, compact controller segment. Furthermore, all the advantages of the TwinCAT 3 software generation can be utilised, while an extremely compact design with dimensions of just 49 x 100 x 72 mm ensures optimum scalability of PC-based control for small controller applications that typically require minimum footprint.

With multi-functional I/O channels directly integrated, the CX7000 assures excellent value for money:

- 8 digital inputs, 24 V DC, 3 ms filter, type 3
- 4 digital outputs, 24 V DC, 0.5 A, 1-wire technology

These integrated multi-functional I/Os can be configured for other operating modes via TwinCAT 3, enabling the option to use fast counting or processing of analog values:

- counter mode: 1 x 100 kHz digital counting pulse input, 1 x digital input with counting direction increment/decrement, 2 x digital counter outputs
- incremental encoder mode: 2 x digital inputs for 100 kHz encoder signal, 2 x digital encoder outputs
- analog signal mode: 2 x digital inputs configured as analog inputs 0…10 V, 12 bit
- PWM signal mode: 2 x digital outputs configured for PWM signal

If additional electrical signal types need to be processed, the CX7000 can be expanded very easily on demand by adding EtherCAT Terminals or Bus Terminals to the integrated I/Os. Additional I/O terminals will be directly attached to the CX7000.

The Embedded PC is equipped with 512 MB MicroSD flash memory (with the option to upgrade to 1, 2, 4 or 8 GB) and is suitable for operating temperatures between -25 and +60 °C. An Ethernet interface (10/100 Mbit/s, RJ45) serves as the programming interface. This means that the space-saving CX7000 is ideal for use as a cost-effective, stand-alone compact controller. In the CX7080 version, peripheral devices such as displays, scanners or weighing systems can be connected via an additional serial interface (RS232/RS485).

“With the CX7000, users of small controllers can now also benefit from the advantages of TwinCAT 3 and the great EtherCAT device variety.”

Ralf Vienken, Senior Product Manager
Fieldbus Systems and Embedded PC

Equipped with an internal EtherCAT interface, the CX7000 is the first device in the small controller range that can be used with the extremely broad portfolio of Beckhoff and third-party components available for the globally established standard.
Further information:
www.beckhoff.com/cx7000

Product announcement
Estimated market release: 3rd Quarter 2019
C6032: ultra-compact Industrial PC

The C6032 Industrial PC with dimensions of only 129 x 133 x 104 mm extends the range of ultra-compact Industrial PCs by a high-performance modular device. For this purpose, the C6032 adds a further circuit board level to the C6030 single-board Industrial PC to accommodate modular interface and functional extensions. With the use of compact PCIe modules, the C6032 can be adapted perfectly to the requirement profile of individual applications. Equipped with Intel® Core™ i processors of the 6th and 7th generation – up to the Core™ i7 with four cores and 3.6 GHz each – the C6032 is ideal to support extensive axis controls, complex HMI applications, extremely short cycle times or large data volumes.

CX5230/40: compact and modular Embedded PC series with the latest Intel® Atom™ processors

The DIN-rail-mountable, fanless Embedded PCs in the CX5200 series are equipped with Intel® processors of the Atom™ X series. The series encompasses two devices that differ by processor type and RAM:
- CX5230: Intel® Atom™ CPU (1.3 GHz, 2 cores), 4 GB DDR4 RAM
- CX5240: Intel® Atom™ CPU (1.6 GHz, 4 cores), 8 GB DDR4 RAM

These devices supplement the existing devices of the CX5000 series, introducing efficient multi-core technology into the compact Embedded PC range. While the CX5200 series offers the same hardware interfaces as the CX5000 series, the new series can be expanded by connecting a system or fieldbus module of the CX2000 family to the multi-pin terminal on the left-hand side of the device. The modular scalability makes it easy to meet individual application requirements.
EL2596: flexible and highly precise LED strobe control for vision applications

The LED driver terminals from the EL2596 series contain a flexible power supply unit that supplies the LED with the required voltage and current. The terminals support applications from constant lighting to short light pulses in the kHz range. Each individual flash can be triggered by the control system in an exactly defined manner via the distributed clocks/timestamp function. The EtherCAT Terminals feature a trigger input to be directly triggered by a camera as well as a trigger output to trigger a camera. It also features fast, high-end voltage and current control, e.g. for providing line scan cameras with constant lighting. Extensive real-time diagnostics allow detailed monitoring of the LED light intensity. Thus, overdrive applications with short high-current pulses through the LED are possible. If a given load corridor is left, the EL259x switches off to protect the LED, with subsequent reset being possible.

Connectors for One Cable Automation now available in size B40

The connector families ENP and ECP, which were developed for One Cable Automation (OCA) solutions with elevated power requirements, combine EtherCAT or EtherCAT P with additional power cores in the cable. The range of previously available sizes, B12 to B36, has recently been expanded with the B40 connectors (16 mm² wire cross-section). The power contacts of the B40 hybrid connectors each have a current carrying capacity of up to 72 A. Possible applications range up to the 630 V AC/850 V DC level. In addition to pre-assembled products, the flexible B40 product portfolio also includes connectors for field installation and corresponding cable material sold by the metre.

EL2634: relay outputs with extremely high switching capability

The output terminal EL2634 is equipped with four relays, each of which has a single contact, and with potential-free contacts. The relay contact is suitable for use at up to 250 V AC or 30 V DC. Despite its compact form factor, the EL2634 is capable of switching four times 4 A AC/DC at 250 V. The EtherCAT Terminal indicates its signal state by means of light emitting diodes.
The ironless tubular motor AA2518 is able to perform extremely smooth translatory movements, because no cogging occurs, and does not require further mechanical components for power transmission such as e.g. a spindle. With a peak force of 1050 N, an acceleration of 8 m/s and the cogging-free design, AA2518 meets the highest requirements for precision and dynamics. Thus, it is ideally suited for use, e.g., in the packaging industry or the machine tool sector. Because of the design without additional mechanical drive components, the tubular motor is wear-free and the installation is simplified.

The anodised servomotors from the AM8700 series combine the advantages of the highly dynamic AM8000 standard servomotors with features to meet the requirements of the packaging and food industries. Like the AM8800 series motors, the AM8700 motors meet hygienic design requirements and are therefore suitable for use in the food, pharmaceutical and chemical industries. With their specially treated aluminium housing, the AM8700 motors are able to withstand harsh operating conditions without an impact on the excellent thermal conductivity, so that no derating of the motor power occurs. In comparison with a stainless steel housing, the aluminium housing is very light and therefore offers a further benefit if moving axes are involved, e.g. The AM8700 motors are available in flange sizes F3 to F6, each with three different overall lengths. All types offer IP 69K protection as standard (output shaft not included) and can optionally be equipped with a sealing air connection to prevent condensate formation.

Tubular motor: precise and dynamic linear movement without additional mechanical drive components

The ironless tubular motor AA2518 is able to perform extremely smooth translatory movements, because no cogging occurs, and does not require further mechanical components for power transmission such as e.g. a spindle. With a peak force of 1050 N, an acceleration of 8 m/s and the cogging-free design, AA2518 meets the highest requirements for precision and dynamics. Thus, it is ideally suited for use, e.g., in the packaging industry or the machine tool sector. Because of the design without additional mechanical drive components, the tubular motor is wear-free and the installation is simplified.
New UPS series with communication capability

With the new CU81xx UPS series, all Beckhoff components can be safeguarded. A special feature of the UPS series is its compatibility and ability to communicate with all existing Industrial, Panel and Embedded PCs. For communication with the PC, USB 2.0 can be used or UPS OCT via a 24 V line. These interfaces can be used to retrieve status data for diagnostic purposes or to configure the UPS. The series encompasses one capacitive UPS (0.9 Wh) and two battery-backed devices (15 and 30 Wh), depending on the version, with double-layer film capacitors or nickel/metal hydride batteries. The batteries are easily accessible in the UPS to enable easy replacement without having to dismantle the unit or dismount it from the DIN rail.

The TwinCAT library TC3 XTS Extension has been expanded with the Track Management software functionality for the eXtended Transport System (XTS). It enables the combination of a virtually unlimited number of tracks in varying length. In this way it is possible to move motor modules, i.e. track sub-sections between different XTS tracks by means of customer-specific mechanical devices. In addition, the switch between different tracks is possible without having to interrupt the system operation. One of the manyfold application examples of this functionality is discharging a mover from an otherwise closed system or replacing it with another mover in order to implement automatic tool changes or fast format changes e.g. With a switch functionality implemented in this way it is also possible to have movers alternate between two or more systems in order to integrate optional workstations. Other applications could be the implementation of product buffers, storage in warehouses or product sortation.
AMP8620: IP 65 supply module expands the AMP8000 distributed Servo Drive system

Drive technology without control cabinets through consistent decentralization

The AMP8000 distributed Servo Drive system provides ideal support for the implementation of modular machine concepts. With the new AMP8620 supply module in a high protection rating, the entire system can now be relocated directly to the machine, i.e. through consistent decentralization, drive technology can be implemented entirely without control cabinets. That means maximum possible savings on material, space, costs and assembly work.

While with the coupling modules, the requirements for connecting distributed AMP8000 drives to the control cabinet were already reduced to just one cable, they can now be completely eliminated when the AMP8620 supply module is used. Eliminating the need for a control cabinet further reduces the floor space and cabling requirements for the entire machine. The air conditioning resources, which would otherwise be necessary for control cabinet cooling, can also be eliminated.

The AMP8620 module is directly connected to the mains supply. It contains all circuitry components required for that purpose, such as mains filters, rectifiers and charging circuits for the integrated DC link capacitors. The supply module enables optional connection of additional distribution modules or distributed AMP8000 Servo Drives. It is equipped with two EtherCAT P outputs, through which either EtherCAT P modules can be supplied or else additional supply modules can be connected that may be required for system expansion. The safe 24 V power supply unit integrated in the supply module ensures that the logic power supply does not exceed the permissible level. The DC link capacitors integrated in the supply module store the regenerative energy of the entire system and then make it available again for acceleration processes. This ensures best-possible utilisation of the energy supplied.

Further information:
www.beckhoff.com/amp8620

Estimated market release:
3rd Quarter 2019
TwinCAT Scope meets OPC UA

In the context of Industrie 4.0 and big data applications, machine data acquisition is becoming increasingly important. The information must be presented in a clear and efficient manner, and the machine control system also has to cover a wide range of other smart components. TwinCAT Scope software provides optimum support for such integrated data acquisition across heterogeneous system environments. A standardized OPC UA communication channel enables this charting tool to analyze data from diverse sources such as TwinCAT controllers and third-party components.

TwinCAT 3 Scope consists of Scope View for the graphical display of signal curves and Scope Server for the actual data logging. The Scope Server can be installed on a target device for autonomous logging (without the View component if desired) or on the corresponding engineering system together with Scope View for remote logging. The latter solution offers the advantage that no additional software has to be installed on the target device. As a result, no updates to TwinCAT controllers are required, and devices without TwinCAT do not have to be modified in order to display their data graphically in Scope View.

Vendor-independent, secure data collection via OPC UA

For logging measured signals, the Scope Server now not only features a TwinCAT-specific ADS channel, but it also offers support for another standardized communication channel, which is realized as an OPC UA client. The widespread use of OPC UA in automation technology enables TwinCAT Scope to acquire and display measured data in a vendor-independent way. With OPC UA, this can be achieved reliably and securely, especially if certificates are used.

The TwinCAT Target Browser, which is used for managing the connected data sources in TwinCAT Engineering, has also been expanded with OPC UA support. It enables browsing in the namespaces of connected OPC UA servers. This feature can be used to select the desired variables for logging by the Scope Server with configuration options for certificate-protected access.

A TwinCAT 3 Engineering installation always includes a Scope View and a local Scope Server. Both software components are included free of charge in the basic version, which enables testing of the OPC UA communication. With a rich set of features including multi-core support, triggers, chart synchronization and numerous zoom functions, the tried and tested charting tool is now perfectly suited for an even larger group of users and even more diverse application scenarios with these latest communication enhancements.

Further information:

www.beckhoff.com/twinCAT-3-scope
In an interview with Günter Herkommer, editor-in-chief of the Computer & Automation trade journal, Hans Beckhoff gives a review of the last 20 years in PC-based control technology and an outlook on future developments.

Mr. Beckhoff, at the end of the 90s, there was major debate in the trade journals: Is the Industrial PC gaining acceptance in industrial automation and is the traditional PLC on the way out? The former has happened, but the PLC is still alive and kicking. How would you sum up the last 20 years of control technology?

Hans Beckhoff: A lot changes in two decades. In automation technology in particular, there are exciting innovations every year – sometimes even revolutionary ones; however, the actual impact on the market is not usually seen until 10 years later.

At Beckhoff, we delivered the first Industrial PC back in 1986, which means that we have had PC-based control technology ever since. And as early as 1990, during our first presentation at the Hannover Messe trade show, a journalist asked me how long the PLC would still be around? As a young engineer, I leaned back and said: Another five years – an incredibly long time for me at the time!

When this journalist asked me the same question again in 1995, Beckhoff was doing well and we had grown wonderfully with our technology – but PC-based control technology only accounted for a negligible share of the overall market. On the one hand, this is due to the time constant mentioned at the beginning. On the other hand, there is of course a certain inertia on the part of the large suppliers of control technology, which encourages them to stick with the tried-and-tested technologies – such as PLC technology.

Nevertheless, we are convinced that IPC technology is by far the most powerful and often the least expensive platform. It also is a platform that enables the best possible integration of IT and automation features.

Also around the turn of the millennium, the hour of Ethernet began to strike in the industrial environment. In 2003, Beckhoff itself presented EtherCAT, a corresponding solution that is now internationally widespread and accepted. Did you expect it to become so successful?

Hans Beckhoff: We were indeed optimistic and knew that what we had was something good. But we weren’t aware at the time that we were defining a kind of global standard with EtherCAT. As it happened so often in our company’s history, we progressed with a certain ‘naïve’ optimism and belief in our own strength and developed this technology out of our own conviction.

At that time, however, we were already seasoned fieldbus experts: On the one hand with regard to our own communication systems, which we had already launched on the market. On the other hand, we also knew all the other fieldbus systems – essentially CAN bus and PROFIBUS. Compared to all these existing solutions, the development of EtherCAT ultimately represented a real quantum leap: On the one hand in terms of performance, which we had optimized in such a way that we could use a single Ethernet telegram to collect bits and pieces of information from many participants in the field. On the other hand, we built distributed clocks into the system from the outset in order to integrate an absolutely accurate system time into an automation system. Another novelty we introduced: At the time, every bus had to have a master card – a fact that is almost forgotten today. With EtherCAT, this was no longer necessary; instead, the system could be operated on any standard Ethernet port.

After the first positive reactions from the market, we finally decided to make the EtherCAT technology available for open use. In this context, we founded the EtherCAT Technology Group. The release of the technology has certainly contributed significantly to the worldwide success of EtherCAT.

In your opinion, what other developments – apart from IPC and Ethernet – have had a significant impact on automation technology over the past 20 years?

Hans Beckhoff: In 1998, we were able to offer IPCs with one CPU core and a clock frequency of 1 to 2 GHz for controlling a machine. Today we supply Industrial PCs with up to 36 cores and a clock frequency of 4 GHz. This shows that hardware development has made great progress – in other words, Moore’s law has proven its validity over the years. And we believe that this will be the
At Beckhoff, we have also founded a working group that investigates artificial intelligence algorithms for possible applications in automation. The first results in these fields are very promising!

case for at least the next 10 years. If today we can integrate image processing or measurement technology into the control system, if we can synchronize 100 axes in one machine instead of 20 and if path control is possible at the same time, then we owe it to this increase in performance.

Another decisive development over the past 20 years has been the combination of functional areas, for example by integrating safety into standard control technology. And as far as drive technology is concerned, such new drive types as our XPPlanar, the levitating planar motor system that we nicknamed the flying carpet, and of course, the eXtended Transport System (XTS) based on inverse linear motors have been successfully introduced to the market. Basically, I see a trend for the future in specialized magnetic drive forms, because today they can be mastered algorithmically, which means that a lot of mechanical effort on the machine can be replaced by software functionality.

Especially with regard to software, the last 20 years have also been the time when the IT world has moved even closer together with the automation world. In the case of TwinCAT 3, for example, it has meant the integration of the various tool chains such as Visual C, C++ and IEC 61131 into Microsoft Visual Studio. A further advantage lies in the integration of MATLAB®/Simulink® and then measurement technology and image processing as a result. In short: I consider this consistent integration of functions originating from different areas or even from different companies in one software package to be one of the most important development trends of the last two decades.

All in all, automation technology has, in retrospect, become simpler and more cost-effective. Think, for example, of one-cable technology or the electronic motor nameplate – 20 years ago, this was either rare or non-existent. At the same time, costs per axis in control technology have decreased by between 20 and 40% during this period.

One topic that has been on the Beckhoff agenda for over six years, but for which Beckhoff has not yet presented a market-ready solution, is completely PC-based or freely programmable safety technology. Why does this topic seem to be such a difficult one?

Hans Beckhoff: There are two different things that we have to consider here: First, we have been supplying hardware-based safety – i.e. the input and output terminals or safety logic terminals – for around 10 years now. These are freely programmable with a graphical editor and cover around 80% of all standard safety functions. We have also decided to do without the safety hardware CPU and replace it with a purely software-based runtime. We have already developed the mathematical basics and special compiler techniques to do so. Internally, this is now a finished product – the only thing still missing is a simple graphical editor. It will be available by the end of next year and then the official market launch will take place!

Industrie 4.0 has been a major topic in the industry for more than five years now. What is your own definition of Industrie 4.0 and how do you see the industry today in this respect – internationally as well?

Hans Beckhoff: Industrie 4.0 is a complex topic – and that’s why your question is not so easy to answer, especially because such buzzwords as digitization and IoT are often used in this context.

Let’s start with digitization: Digitization is something that the industry and the world have been experiencing since 1970. The further development of hardware and software concepts has permeated more and more areas of life – and thus also industry – with electronic data processing aids. In this respect, I don’t see a major leap in development, but rather a development that has been going on for a long time but is accelerating. The fact that German industry is still very competitive shows that domestic companies have done their homework quite well in this respect compared with other countries.

The third industrial age, in which we found ourselves until recently, was based on the Acatech model – which, as we know, invented the term Industrie 4.0 in the year 2011. In this model, the production environment is characterized by the local intelligence of machines. The fourth industrial age, which has just begun, is now characterized by the fact that this local intelligence is combined with cloud intelligence. This is already my main concept of Industrie 4.0 – i.e. machines that can ‘talk’ to each other via the cloud or call up services from the cloud and use them for processes on the machine. Conversely, a higher-level intelligence can also see the machines as an extended output arm.

At Beckhoff, we can well imagine that some machine intelligence is shifting towards the cloud – we call this the ‘avatar concept.’ Examples of this are the
control of a machine with speech recognition running in the cloud or vibration analyses for predictive diagnoses, which do not have to be carried out online, but can be carried out offline in the cloud. Even today, however, we can ‘cloudify’ the entire PLC – depending on availability, bandwidths and achievable response times. With technologies such as 5G, a lot seems to be feasible here; however, the response times here are still above 1 ms – so a packaging machine, for example, cannot yet be controlled in this way.

Now we can make a projection and ask: What will communication look like in 20 years? Personally, I think that we will then be around 100 GBaud and, with the help of special switching and wireless technologies, we will be able to reduce the response times for centralized applications to well under a millisecond. And so in 20 years, your colleagues will be able to write retrospectively: 2018 was the time when the machines hesitantly began to talk to the cloud and retrieve services from the cloud – today, this is completely normal!

In your opinion, what further developments will decisively change automation in the next 20 years?

Hans Beckhoff: The basis for intelligence on the machine is, among other things, the hardware. This will continue to be determined in the next few years by Moore’s law, so that in 20 years we will certainly be able to use computers on machines that are 100 times more powerful than today. That would mean that you can control 100 times as many axes or cameras, or you can operate a machine with a lot of cameras 10 times faster. In this respect, we believe that, for example, the use of image processing systems on the machine – also as sensors and not just for workpiece evaluation – will increase dramatically.

On the other hand, as computing power and communication bandwidth increase, so do the cloud’s capabilities – at least by the same factor. Here, too, the engineer’s imagination is ultimately required to decide what can happen in this cloud. In this context, terms such as artificial intelligence (AI) and machine learning emerge – topics that will certainly have repercussions on machine functionality not in 20 years’ time, but in the next two to three years. At Beckhoff, we have also already founded a working group that investigates artificial intelligence algorithms for possible applications in automation – including path planning in robotics and sensor data fusion. The first results in these fields are very promising!

In the age of Industrie 4.0, there are more and more traditional IT companies or internet corporations, such as Google, Amazon and others, who are trying to make a mark on industrial automation. Are the established automation technology manufacturers now running the risk of losing their ‘piece of the pie’?

Hans Beckhoff: I don’t think so. After all, the big IT companies – Google, Microsoft and SAP – are approaching the application level from above. In other words, they have introduced edge computing concepts that in turn can contain local intelligence as well as machine control intelligence. In this respect, traditional machine control manufacturers are still way ahead in terms of their knowledge base, because automation technology is really complex. So I’m not worried that Google might suddenly offer motion controls or more complex measurement technology. And what’s more, the market is simply too small for these companies.

The large IT companies are primarily interested in the data because lucrative business models can be derived from it. Controllers or machine builders can supply this data.

But aren’t these business models, rather than the pure control hardware, the attractive ones with which machine builders will also want to earn their money in the future?

Hans Beckhoff: As far as that is concerned, there will certainly be competition between automation suppliers and data processors. In addition, many machine end users have also developed their own strategy for this purpose.

Nevertheless, we hear again and again that data is the oil of the 21st century. In order to implement the new data-driven business models, however, users must also be prepared to make their data available. Is this one of the major reasons why it usually doesn’t work yet?

Hans Beckhoff: Let me put it positively. First of all, I think that the fear for data security is much more pronounced in Germany than in other countries. However, if you want to successfully develop business models in this area, you should put that fear aside and consider what you could gain from all the data. Within the German AI community and even within the Federal Government’s ‘key issues paper on artificial intelligence’, there is a proposal to develop an anonymized general database into which personalized data can be imported and then made available anonymously as a general data pool for a wide range of different possible uses.

There are also many other practical methods: We have agreed with some of our customers, for example, that they occasionally run a test cycle on the machine that makes no statement about what has just been produced. During this test cycle, data is written that can then be used for predictive maintenance.

In short: There are solutions to the problem of data security. I would always recommend not putting too much emphasis on fear at first, but rather looking positively at the different options available instead.

OPC Foundation appoints Stefan Hoppe as President and Executive Director

The OPC Foundation’s Board of Directors has elected Stefan Hoppe, Senior Manager Strategic Technologies at Beckhoff, as its new President and Executive Director. Beckhoff was quick to recognize the value of establishing standards in industrial automation and to implement them proactively in its products. For instance, in 2006, the company unveiled its first OPC UA Server, which it went on to officially market as a TwinCAT supplement and deploy in initial customer projects in 2007. To this day, Beckhoff is an active member of OPC Foundation Technical Working Groups and is currently involved in the companion specifications for Euromap, Robotics, Umati, PackML, Euromap and AutomationML. In addition, Beckhoff has the most recent versions of its products and their latest functionality tested every year to ensure their real-life interoperability and stability.

Hannover Messe USA meets IMTS: Beckhoff receives ministerial visit

As part of a four-day trip to the U.S. in September 2018, Prof. Andreas Pinkwart (right), Minister for Economic Affairs, Digitization, Innovation and Energy for the German federal state of North Rhine-Westphalia, visited the Beckhoff booth with a business delegation as part of the Hannover Messe USA meets IMTS show in Chicago. Pinkwart was greeted by TwinCAT Speech with the words: “Good morning Prof. Andreas Pinkwart. Welcome to the Beckhoff booth at Hannover Messe USA!” The government minister was then shown several more exhibition highlights, including TwinCAT IoT, robotics, motion control and EtherCAT P, by Jörg Rottkord (left), Area Sales Manager North America, International Sales & Business Development.
Dr. Ursula Frank joins the Research Advisory Board of “Plattform Industrie 4.0”

Dr. Ursula Frank, Project Manager R&D Cooperations at Beckhoff, has been appointed to the Research Advisory Board of Plattform Industrie 4.0. The board consists of 16 industry representatives and 20 from science and academia. The Plattform Industrie 4.0 project was set up in 2013 as a joint initiative by the German trade associations Bitkom, VDMA and ZVEI. Headed by Peter Altmaier, Germany’s Federal Minister for Economic Affairs and Energy, and Anja Karliczek, Federal Minister of Education and Research, the project aims to safeguard and expand Germany’s international lead in the manufacturing sector.

Dr. Guido Beckmann elected to Board of VDMA’s Electrical Automation association

Dr. Guido Beckmann was elected to the Board of the VDMA’s Electrical Automation association at its most recent general meeting. Guido Beckmann is Senior Management Control System Architecture & International Key Account at Beckhoff. Dr. Beckmann and his fellow board members’ period of tenure in the board of the association continues through to 2022.

Frank Schubert appointed spokesperson for BIG-EU Advisory Board

At the annual meeting of the BACnet Interest Group Europe (BIG-EU), members elected a new leadership team for the next two years. Frank Schubert, who heads Marketing and Training Building Automation at Beckhoff, remains an advisory board member and has been chosen to succeed Professor Peter Fischer from Dortmund’s University of Applied Sciences and Arts as the board’s spokesperson. BIG-EU is a European business organization that develops and markets BACnet-based building automation solutions.
Flexible communication across building and mobility applications with OPC UA
Empa (Swiss Federal Laboratories for Materials Testing and Research) conducts interdisciplinary energy research in the building and mobility sectors inside an actively used living and working environment on its campus. Empa relies on the OPC UA communication standard to interconnect its research infrastructure – three large-scale projects named “NEST,” “ehub” and “move” plus all components involved in producing, storing, transporting and converting energy. Data communication – from control traffic between devices to data analysis in the cloud – is handled by CX5140 Embedded PCs running TwinCAT 3 OPC UA software.
Research units can be added to NEST easily using a large-scale plug-and-play principle.

The NEST, ehub and move demonstrators

- NEST is a building with a modular, flexible structure consisting of a central core – the backbone – and three open platforms. Individual research and innovation modules can be installed on these platforms, which serve as building floors, according to a large-scale plug-and-play principle. These modules, or units, serve not just as dwellings or places of work but also as test labs operating under realistic conditions. The units are connected via thermal and electrical networks, across which they can interact with one another.

- The ehub energy research platform connects the other two demonstrators – NEST and move, which are located in separate buildings. However, it can also control all energy infrastructure components individually in line with specific research requirements. Rather than treating NEST as a single entity, ehub sees the various NEST units as separate buildings. In conjunction with the NEST and move demonstrators, ehub can be used to combine energy flows in the areas of mobility, housing and work, to test new energy concepts under real-world conditions, and to explore the potential for increasing efficiency and reducing carbon emissions. Empa’s Philipp Heer explains: “The Energy Hub is a typical energy center, complete with the usual physical components like heat pumps, geothermal probes and batteries, serving a total of 15 buildings. More interesting, though, is how it works at the control level: It operates as a virtual platform for control and energy management projects.”

- The demonstrator and technology transfer platform for mobility research, move, supports the development and trial of new types of vehicle drives designed to produce significantly lower carbon emissions. Excess power from photovoltaic or hydroelectric plants serves as an energy source for charging electric vehicles and producing hydrogen and synthetic methane for fuel cell and natural/biogas-powered vehicles. The connection between ehub and move allows a shift of renewable energy from the building sector to the mobility sector, where it is either used as fuel or stored in the form of hydrogen.
Empa, an interdisciplinary research institute and member of the ETH Domain – composed of university and research institutions – is working to bridge the gap between the lab and real-world applications. One primary focus of its work is on energy and sustainable building technologies based on research and technology transfer platforms called demonstrators. These include the Next Evolution in Sustainable Building Technologies (NEST), the Energy Hub (ehub) and the demonstrator for future mobility (move). Working in close collaboration with research and industry partners, Empa uses these large-scale building, mobility and energy projects to deliver market-ready solutions in those sectors.

Open, clearly defined interfaces with PC-based control and OPC UA

Given that Empa’s demonstrators are available to a wide range of users, it was essential to create an open, manufacturer-independent platform with clearly defined interfaces, according to Philipp Heer, ehub Group Leader at Empa: “The units have just a single physical link to the NEST backbone that connects them with the thermal and electrical systems. Each unit operates independently and incorporates its own automation solution, which communicates via Ethernet. The challenge here is to integrate new units into the demonstrator infrastructure with as few limitations as possible so that systems can be maintained by service technicians and used safely and to their fullest potential for research purposes as well. From an integration point of view, flexibility is essential because the system boundaries shift whenever we add a new unit.”

Enabling flexible access from outside the Empa campus was another challenge. To achieve this, the process control level was implemented in the cloud rather than on internal servers. In addition to other requirements, this called for a specialized control system software architecture that would ensure safe system operation yet allow actuator override where necessary for research purposes. For Philipp Heer, Open Platform Communications Unified Architecture (OPC UA) was the ideal communication technology to meet the requirements for a highly complex and flexible system of this kind: “We use OPC UA across the board, for everything from device-to-device communication at the control level all the way up to data analysis in the cloud and research integration. We developed an OPC UA information model specifically for this purpose. This model lets us integrate new units and components based on standardized specifications. To keep the integration effort as low as possible and ensure consistency, we incorporated parts of the software architecture into the OPC UA information model itself. This approach also allows us to implement new Internet of Things (IoT) software and services without having to adapt the system.”
Embedded PCs with TwinCAT OPC UA drive data communications

Ten CX5140 Embedded PCs running TwinCAT OPC UA software (TF6100) control the communication among Empa’s three demonstrators. Philipp Heer explains: “We have seven CX5140s operating on the NEST backbone as TwinCAT OPC UA servers and clients that we use to connect heating, ventilation and room automation systems. The other three Embedded PCs work as central management systems in NEST to hook up the micro grid and integrate the units. The system as a whole monitors some 60,000 OPC UA objects, including a number of data point instances needed for building automation or to provide researchers write access. Around 6,000 relevant sensor signals from these objects are logged straight to a database. Despite the scale and scope of the system, there have been no performance issues so far. The TwinCAT OPC UA Gateway offers a distinct advantage here: It provides a central point of access to the entire information model, where each sensor is mapped to a corresponding structure. With this setup, all of the information contained in the database and from integrated systems such as LabVIEW™ can be accessed easily through a single interface.”

Empa’s OPC UA communication in detail

- The OPC UA transport layer: the Empa demonstrator park is modular in structure. Separate controllers operating as OPC UA servers and clients control the various subsystems on the NEST backbone, in the NEST units, and in the ehub and move demonstrators. The subsystems communicate with one another and with the TwinCAT OPC UA Gateway in the cloud over OPC UA; all the OPC UA servers can access the gateway as a shared server. The latter also serves as an access node for higher-level databases, research templates and SCADA systems. Empa implemented device-to-device communication between CX5140 Embedded PCs using OPC UA client PLCopen function blocks available in TwinCAT software.
- The OPC UA information model: The NEST information model is based on object types defined for every device and sensor group. These object types differentiate between read and write operations, and contain all key data points. There is one object type per device group; the object types can be instantiated to objects as often as required. This establishes a hierarchical structure in which the objects can be queried via OPC UA server namespace with different resolutions.
- Machine-to-machine communication: The plants at Empa’s demonstrator park use a wide variety of controllers. All measured values and control outputs from the plants are processed by their respective controllers, which are connected over I/O or bus systems, then made available via the objects defined in the OPC UA namespace.
- Machine-to-human communication: Each plant can operate either in normal or research mode. In research mode, the control system logic is overridden. A function block was created for each actuator to make this possible. Each function block can be accessed via two OPC UA write instances for the two operating modes.
Another valuable feature from Philipp Heer’s perspective is that the classic building automation system, implemented using the TwinCAT Building Automation Library, can be manipulated directly over OPC UA: “We can override any individual actuator to suit the needs of specific research projects. TwinCAT OPC UA lets us create new instances elegantly and easily within the information model’s tree. Researchers are only able to see their own particular tree — in much the same way as the building automation system can only see its own tree for normal operating purposes. We can choose and apply the requisite permissions via a selector implemented in the Beckhoff control system. This is both extremely flexible and fast, which is a huge advantage.”

_Abbildung 1: Beckhoff Control System (bottom)_

**Flexibility – the core advantage of PC-based control**

Empa began using PC-based control technology from Beckhoff in 2013 — initially, to automate a small research building equipped with a large number of different interfaces. Says Philipp Heer: “One important factor besides the compact design was the variety of interfaces, which went well beyond the usual array of building technology standards like DALI, KNX or M-Bus. The building relied on additional industrial communication protocols, which we also had to accommodate. The project called for a mix of Bus Terminals and EtherCAT Terminals, which was not a problem with Beckhoff technology. The outstanding communication performance of EtherCAT is another big advantage for us, especially in situations that require exceptionally precise measurements.”

A further benefit of PC-based control is that it allows the seamless integration of energy measurement technology. For instance, Empa uses around 25 EL3403 and EL3443 EtherCAT three-phase power measurement terminals to record and analyze key electrical data in its supply network. TwinCAT Scope also makes work even easier, as Philipp Heer explains: “With TwinCAT Scope’s ease-of-use and powerful analysis capabilities, we can test controllers using high-resolution data and evaluate disturbance inputs exceptionally well.”
In remote laser material machining, focused laser beams are diverted onto the workpiece via highly dynamic adjustment of mirrors known as galvanometer scanners.
In remote laser material machining, a focused laser beam is diverted by rapidly adjustable mirrors known as galvanometer scanners – or scanners for short – and moved highly dynamically along the contour of the workpiece surface to be machined. On account of the distance between the scanner mirrors and the material, the speed of the laser beam on the workpiece can reach several meters per second. The higher the required machining speed, the faster the scanners have to be aligned.

Normally the scanners are controlled by special purpose plug-in PC cards and electronic modules, which control the path movements at the same time. Apart from fast control of the scanners, the main challenges are the monitoring and optimization of the process as well as the interaction with other machine elements. Several movements in the process often have to be coordinated with one another, for example the synchronization of the laser beam movement with a conveyor belt for the material feed. In addition, the process parameters

Productivity increase for laser material machining applications

The Fraunhofer-Institut für Werkstoff- und Strahltechnik (IWS) Dresden (Fraunhofer Institute of Material and Beam Technology) carries out research and development work in the fields of laser and surface technologies. In one application for high-speed laser material machining, the process was optimized using technologies from Beckhoff. Moreover, Fraunhofer IWS Dresden has developed its own EtherCAT module.
ESL2-100 EtherCAT module optimizes laser control

For better integration of the scanners into automation systems, Fraunhofer IWS Dresden developed a special electronics component— the ESL2-100 module. This enables control of the scanner directly from the machine controller by means of EtherCAT. As a result, the communication among the scanners, the machine controller and peripheral components are optimized with regard to universality, real-time capabilities and synchronicity. “With conventional solutions, the entire contour to be traced often has to be transmitted to the scanner controller in advance. Adjustments during operation are possible only with great difficulty. With the ESL2-100, we now calculate the path movements entirely in the PC-based NC and PLC,” says Peter Rauscher, head of the Laser System Technology Group at Fraunhofer IWS Dresden. “The setpoint and actual values for the scanner movement as well as the status and diagnostic values are communicated between the module and the controller. Interventions in the motion sequence are possible in real-time. The scanners can simply be integrated as motion control axes, for example in the TwinCAT NC automation software.”

Practical use: Laser treatment of electrical steel sheets

An application implemented using the ESL2-100 modules is the laser treatment of electrical steel sheets, such as those used for the construction of laminated transformer cores. Thermal stresses are introduced into the sheets by means of laser radiation in order to increase the energy efficiency of the transformers. This Laser Magnetic Domain Refinement (LMDR) was developed collaboratively by Fraunhofer IWS Dresden and a consortium of the companies Coherent-ROFIN and Karl H. Arnold Maschinenfabrik. This method has already been put to use several times in industrial applications. The electrical steel sheet is moved under the laser machining level in the form of belt material. Together with four laser beam sources, 12 scanners as “single axes” are synchronized with a belt feeding speed of up to 140 m/min.

Meeting high performance and versatility requirements

The application relied on an Industrial PC from Beckhoff running TwinCAT 3 automation software to achieve control cycle times of < 100 µs. EtherCAT Terminals processed the input signals at up to 100 kHz and switched the laser
The software solution developed by Fraunhofer IWS Dresden for the LMDR runs on a Beckhoff C6650 Industrial PC with EtherCAT as the communication system for the I/Os and drives. Safety-relevant actuators are integrated via TwinSAFE and other fieldbus devices via PROFIBUS.

The ESL2-100 module developed by Fraunhofer IWS dynamically adjusts the process parameters and the movement of the scanners, depending on the machining process and belt feed. “The solution we created fulfills the industry’s requirements for high machining speeds with constant machining quality. Ultimately, we were even able to increase machining productivity by more than 15 % as a result,” the scientist emphasizes.

**Outlook on further developments**

Future applications will necessitate a modification of the laser beam in order to optimize the machining with different movements, surfaces and materials. “In the future, our system will be able to modify the laser beam movement and control of the laser beam source in real-time – practically as we like,” says Peter Rauscher. A new experimental system with Beckhoff technology for the remote laser cutting and welding of metals and non-metals, such as fiber-reinforced materials, has been installed at Fraunhofer IWS Dresden.
Retailer Journeys sets course for dynamic growth in e-commerce

To keep up with the continuing rise in online sales, retailers must design better websites, expand their shipping capacities and optimize their logistics processes. This challenge is very familiar to U.S.-based retailer Journeys, which specializes in footwear from brands that are popular with young adults, such as Adidas, Fila, Converse and Vans. Together with its partner Fortna, Journeys recently upgraded its distribution center with PC-based control technology.
Small picture: The Journeys distribution center in Lebanon, Tenn., supports order fulfillment for hundreds of stores and the footwear retailer’s growing e-commerce sales.

Large picture: Each line features a pole-mounted CP3919 multi-touch Control Panel that is connected to the control cabinet via the CP-Link 4 One Cable Display Link.
Journeys first partnered with software specialist Fortna in 2000 to design and implement its warehousing and logistics center in Lebanon, Tennessee. The facility originally extended over 320,000 square feet to support 800 brick-and-mortar stores with 17 million SKUs (stock-keeping units) per year. In 2015, the boom in online shopping prompted Journeys to begin planning a major warehouse upgrade, which was completed in 2017. Besides increasing its capacities, Journeys wanted to raise its throughput and optimize its order fulfillment processes to best serve its successful store business while boosting online sales and satisfying new consumer demands such as same-day or next-day delivery. William King, group vice president of integrated technology solutions for contractor Fortna, explains: “As part of the expansion project, we increased the distribution center’s capacity by adding a new conveyor and picking system. We also upgraded the warehouse control system with our FortnaWES™ Warehouse Execution System (WES) software and the supporting hardware.”

Fortna Inc., which is headquartered in West Reading, Pennsylvania, and has locations in several other countries, designs and implements logistics solutions including its industry-specific FortnaWES™ software for companies across the globe. The company helps customers implement innovative control technology while leveraging legacy systems for better results. To integrate the controllers and field devices in the Journeys warehouse and optimize its logistics processes, Fortna made full use of the openness and flexibility of PC-based control technology and EtherCAT.

**At a glance**

**Solutions for intralogistics**
- upgrade of a retailer’s warehouse and distribution center

**Customer benefits**
- expanded capacities, increased throughput and optimized order fulfillment
- all systems integrated within a heterogeneous logistics environment
- seamless migration to the new solution with minimized downtime

**Applied PC Control**
- TwinCAT 3 as the engineering platform for upgrading the controls layer of the FortnaWES™ warehouse execution system software
- TwinCAT 3 TCP/IP for real-time communication between controls layer and business layer
- CX2030 Embedded PC and CP3919 multi-touch Control Panel for line control

Mandatory in logistics: maximized throughput and minimized downtime

The specifications for the upgrade were dictated by the distribution center’s high throughput requirements. For example, high-speed sorters and merges had to be capable of handling more than 130 boxes per minute with incredible accuracy, because a single mistimed box can jam the conveyor and bring the entire operation to a halt. Since unplanned downtime is something that a company like Journeys simply cannot tolerate, the order fulfillment operations even had to continue during the warehouse expansion, says Jeremy Davidson, director at Fortna. To solve this problem, the migration was carried out in phases. First, Beckhoff controllers were added to execute the legacy software. Next, the fieldbus communication was upgraded to EtherCAT, and finally complete automation solutions were implemented based on TwinCAT and CX2030 Embedded PCs.

To minimize downtime during the migration, Fortna installed an extra CX2030 Embedded PC near the main line controller. This enabled the operator to simply move the Ethernet cable and CFast flash memory card to the new unit as needed.

Since any unapproved access to the distribution system over the internet can slow down or even stop its operation, protection of the network infrastructure was another requirement: “Security has rightly become a critical area of focus,” says William King.
Real-time automation raises transactions to a new level

Fortna based an upgrade of the control application layer for its FortnaWES™ warehouse execution system software on the TwinCAT 3 automation platform. The resulting Fortna Real-Time Controls (FRC) replaced the company’s 25-year-old FortnaPlus™ software. According to William King, TwinCAT’s TCP/IP-based communication is particularly important: “Ethernet TCP/IP is the protocol that allows our FRC controls layer to talk to our business layer in real-time and process thousands of transactions per hour. Anytime we scan a carton at a sorter, for instance, the controls layer asks the business layer ‘Where should this go?’ The business layer, which contains the logic, may respond ‘Take it to Lane 6’. All of this happens in hundred-millisecond cycles, and direct TCP/IP communication from the PLC makes it possible.”

On the hardware side, operators interface with the WES through a CP3919 multi-touch Control Panel on each line. A CX2030 Embedded PC equipped with a dual-core processor handles the control functions. The PC’s form factor makes it more accessible to engineers in the industry, according to William King: “Many in the material handling and distribution industries are still locked in the PLC mindset. A PC-based industrial system that mounts on a DIN rail inside an electrical cabinet like a PLC looks familiar to them and is accepted more easily.”

Using EtherCAT as the industrial Ethernet fieldbus, Fortna is able to leverage distributed I/O concepts. “EtherCAT was a compelling technology for Fortna from the beginning due to its wide acceptance in the logistics industry,” says Doug Schuchart of Beckhoff USA. “It possesses the unique ability to support the data exchange of more than 65,000 devices over networks with a wide range of topologies and speeds in the realm of microseconds.”

Successful logistics upgrade for e-commerce

When the Journeys distribution center went live in April 2018 after successful completion of the upgrade, the results were impressive: expanded storage capacity, an overall increase in carton throughput and the ability to fulfill e-commerce orders more efficiently.

Together, Fortna and Beckhoff have demonstrated how automation technology and modern logistics solutions can be used not just to manage the risks caused by growing e-commerce sales, but also to take advantage of their inherent growth opportunities.

Further information:

www.fortna.com
www.journeys.com
www.beckhoffautomation.com
Teams at the 35th America's Cup competed on AC50 catamarans with 15m hulls.

Emirates Team New Zealand won the America's Cup for the third time.
Emirates Team New Zealand relies on PC-based control and EtherCAT in America’s Cup contest

In June 2017, Emirates Team New Zealand pulled off an emphatic victory in the 35th America’s Cup in Bermuda with a 7-1 win over Oracle Team USA. The New Zealand team also won the Louis Vuitton Trophy during the qualifier event, beating contenders from Britain, France, Japan and Sweden. PC- and EtherCAT-based control technology on the New Zealand boat proved to be a crucial aid for fast, precise trimming — the process of tuning the hydrofoils and the wing sail’s position and profile to suit the wind, course and swell. Beckhoff, now on board as an official supplier for the team’s title defense bid, can report on the technology deployed in the oldest sailing race still held today.
Emirates Team New Zealand has a number of technical requirements that are less than typical in traditional industrial applications. The team needs compact, lightweight, high-performance controllers capable of withstanding high temperatures, moisture, saltwater, vibration and shock – requirements that most electronic components are not designed to meet.

Outstanding performance in harsh conditions

It was the compact design and low weight of Beckhoff control technology that caught Emirates Team New Zealand’s eye. “When racing sailboats made entirely of lightweight composite materials, installing heavy electronic components would be counterproductive,” says Dan Bernasconi, the team’s technical director. Despite their compact, lightweight construction, the Beckhoff components proved exceptionally reliable in an incredibly tough environment. “In spite of the conditions we operate in, not one of the Beckhoff components failed, and they required practically zero maintenance – even after we capsized spectacularly,” adds electronics engineer Stefano Morosin.

Emirates Team New Zealand’s boat was the only one in the race not fitted with winches. Instead, all the vessel’s trim surfaces, barring the rudder, were controlled over EtherCAT by a Beckhoff Embedded PC. This resulted in exceptional precision, repeatability and reliability that kept the boat stable, fast and efficient, allowing the crew to virtually fly across the water. “A system capable of responding instantaneously to my input was essential for steering the boat,” explains America’s Cup winner and Olympic gold medalist Blair Tuke, the team’s foil trimmer.

Flexibility is the key

Using PC-based control for the on-board systems opened up many possibilities for Emirates Team New Zealand. Says control engineer Ryan Thomas: “The fact that we could use any PC software, plus the ease of communication between TwinCAT ADS libraries and the real-time controller – locally and over a network – gave us maximum flexibility when managing the system architecture. This is particularly valuable in a fast-moving development environment with software and hardware changes happening on a daily basis.”

However, these were not the only benefits of the flexibility offered by TwinCAT 3-based control. Emirates Team New Zealand searched everywhere for controllers, sensors and other devices that would meet their exacting expectations. With the wide range of EtherCAT I/O modules, control system-integrated interfaces and gateway bus terminals and box modules from Beckhoff, they achieved all connectivity and communication requirements. With Beckhoff technology, choosing the best option for a given application was never a problem, as Ryan Thomas explains: “Using EtherCAT as our central bus system on board, we got extremely fast response times and could integrate any number of other devices via gateways. When you’re not limited by communication protocols, your options expand enormously, particularly when you’re looking for solutions to highly specialized problems.”

The large quantities of data to be processed from position and pressure sensors, anemometers and other sources, plus the navigation calculations and the racing software all called for an exceptionally fast computer. The CX5140 Embedded PC with an Intel® Atom™ quad-core processor delivers the requisite computing power by making optimum use of all four of its CPU cores. The compact, lightweight design also made the PC ideal for this particular use case.

Advanced diagnostics on board

Fast, precise diagnostics and troubleshooting are crucial when maximizing training and testing times on the water. With PC-based control from Beckhoff, every function on the race boat can be controlled through a web interface on a tablet device. Plenty of time spent on the water is essential to any successful America’s Cup bid, so fast, accurate diagnostics and troubleshooting were crucial to maximize the amount of live training and testing on the actual boat. The diagnostic capabilities of EtherCAT and corresponding tools in TwinCAT 3 detected potential problems quickly – sometimes even before the boat’s crew
spotted them. “In the harsh, wet conditions involved in sailing, connectors will usually develop faults over time due to water ingress and gradual corrosion. The ability to identify early on where this will happen allows us to maximize productive time on the water and avoid situations that could harm the boat,” Stefano Morosin says.

Shore crew and support engineers needed a portable solution with an intuitive user interface to maintain the mechanical and hydraulic systems. Through the web-based HMI options provided by TwinCAT, every function implemented on the race boat could be controlled through a web interface on a tablet device – the ideal portable control unit for maintenance tasks, as hydraulics engineer Vito Vattuone explains: “The ability to actuate any valve from anywhere on the boat, even from the very front of the hull, was exceptionally important for maintenance and trouble-shooting.”

Looking ahead to the 36th America’s Cup
After winning the 35th America’s Cup, the pressure is on for the NZ team to successfully defend its title, especially since it will host the race’s 36th staging in Auckland, New Zealand, in 2021. Each race team will use a Beckhoff PLC to control its hydrofoil cant system via EtherCAT. Emirates Team New Zealand welcomes Beckhoff as an official supplier and looks forward to using the company’s PC-based control architecture to redefine the performance boundaries of high-speed boat racing once again.

Waves of success
Emirates Team New Zealand is the most successful team in recent America’s Cup history. Besides winning the prestigious competition in 1995, 2000 and 2017, it was also the top contender in 2007 and 2013, winning the Louis Vuitton Cup final on both occasions. The team consists of America’s Cup winners past and present, Olympic medalists, world champions and Volvo Ocean Race sailors. The senior management team includes America’s Cup and Whitbread/Volvo Ocean Race veterans as well as Formula 1 design engineers.

Spraying champagne is the traditional way to celebrate victory in this tough sailing competition.

At a glance

Solutions for shipbuilding
– sailboat trim control

Customer benefit
– highly precise, repeatable and reliable trimming
– early problem detection for maximized on-water training and testing times

Applied PC Control
– CX5140, EtherCAT terminals und I/O modules: compact, lightweight and robust control components
– EtherCAT: Ultra-fast communication for instantaneous response to trim commands
– TwinCAT 3: highly flexible and open control architecture

Further information:
https://emirates-team-new-zealand.americascup.com
www.beckhoff.co.nz
Founded in 1983 and located in the Swedish city of Växjö, Ecmec AB produces hydraulic and mechanical fixtures, accessories for robot grippers and customized machines for assembly, part handling and machining operations. The latest example is the newly developed Ecmec SPM (Special Purpose Machine) machining center, which integrates and simultaneously executes all steps for processing up to 200,000 pressure die castings per year for the automotive industry.

From the drawing board to the finished machine in record time
When equipment manufacturers design a customer-specific machine, they must keep an eye not only on component costs but also on development expenses. For this reason, the time from first draft to delivery should be as short as possible. "Since we don’t build a machine of this magnitude every day, we looked for a partner who could supply control and drive components designed to meet customer requirements," says Daniel Eklund, managing director of Ecmec.

The challenges were considerable. Parts that were previously made on two machine tools with three to five axes had to be processed by a single machine operating 18 NC axes simultaneously. Two main spindles are designed as four-axis units, meaning they can move freely along the X, Y and Z axes as well as rotate and tilt. Another three main spindles move as three-axis units supplemented by an additional one-axis main spindle. With this configuration,

TwinCAT 3 controls highly efficient machine for processing of die-cast automotive parts

Cost-efficient production with 18 synchronous NC axes

Swedish equipment manufacturer Ecmec AB has developed a high-tech machine for a supplier to the automobile industry that can complete several process steps simultaneously without having to remount the part being worked on. The machining center is designed for high-volume production of up to 200,000 parts per year and performs its functions and processing steps simultaneously within the same cycle. The machine reduces the previous processing and conversion times by more than one third, while requiring less of the valuable shop floor space with its reduced footprint. Beckhoff supplies TwinCAT 3 automation software for the Ecmec machine’s PLC and NC operations as well as the main spindle and forward-feed drives.

At a glance

Solutions for machine tools
- production of die-cast automotive parts

Customer benefit
- about one third less processing and conversion times
- reduced machine footprint

Applied PC Control
- C6930: ample performance for simultaneous control of 18 axes
- TwinCAT 3 NC I: easy to handle NC modules
- AX5000, AM8000: fast, dynamic and with OCT also space-saving drive solution

In the Ecmec SPM machine, the synchronized spindles move along 18 axes to cut the metal parts with exceptional precision, and the synchronized cutting spindles process the metal simultaneously.
workpieces can be machined on all sides without having to be remounted. A tool changer with four different tools makes the design even more flexible.

“The Ecmec SPM employs a totally different set of processing methods compared to traditional machines and does everything much faster,” explains Eklund. “It processes the workpieces roughly 33 percent faster than conventional machines and requires less machine footprint.”

Precise motion control with faster response times

“Addressing all 18 axes simultaneously requires a fast and powerful control system which is where Beckhoff came into play,” says Daniel Eklund. “To avoid interface problems, we looked for a solution from a single source, and Beckhoff was able to meet all the customer specifications.” The flexible hardware design was another reason for the decision to select Beckhoff technology, because it made a big difference for the project group. “We ran through various alternatives, but the NC I software modules from Beckhoff represented the best option. The Beckhoff system is very powerful and easy to operate, which is something we truly appreciate. It is a prime example of German engineering,” says Eklund.

At the core of the machine is TwinCAT 3 NC I software, which controls the six mechanical spindles simultaneously. The numbers of axes and channels were adjusted to satisfy the application’s requirements with respective option packages. As a highly scalable system, PC-based control also provides the best possible hardware platform for this application. The TwinCAT real-time kernel and the ultra-fast system communication over EtherCAT offer ideal conditions for high-precision motion control, Eklund explains: “This platform provided very fast control properties and a much faster response time than the conventional PLCs we used in the past, which was one of the main reasons why we selected PC-based control technology from Beckhoff.”

In addition, the TwinCAT development environment provides numerous features that make the designer’s work easier. For example, Ecmec’s programmers developed their own control and machine software on the basis of TwinCAT 3. They also opted to use the syntax with G- and M-codes as defined in the DIN 66025 standard, which makes it easier for the machine operators to change setups for new workpieces. These and other features enabled Ecmec to develop this high-performance machine in a very short timeframe.

Control and drive components from a single source

The Ecmec SPM is controlled and operated via a C6930 control cabinet Industrial PC with a custom-designed CP3921 multi-touch Control Panel featuring push-button extensions. The user interface is TwinCAT HMI for NC processing, which is easily programmable based on standards such as .NET. The axes and I/O channels are configured via TwinCAT Engineering with NC I functions.

The two main spindles are equipped with AM8000-series servomotors with speeds of up to 11,000 rpm. The other four spindles ensure a high degree of processing efficiency for downstream processing steps as well. The maximum feed rate is 30 m/min, and the maximum acceleration rate is 0.2 g. The six main spindles and 12 servomotors are controlled by Beckhoff AX5000 Servo Drives for exceptionally fast and dynamic positioning. In addition, One Cable Technology (OCT) saves a significant amount of installation space.

To protect the operators and avoid equipment collisions, all servo drives are equipped with AXS805 TwinSAFE cards. The machine also uses TwinSAFE terminals and the EL6900 TwinSAFE Logic terminal with certified safety function modules and Safety over EtherCAT (FSoE).

Further information:

www.ecmec.se
www.beckhoff.se
Industrie 4.0 is finding its way into the construction sector

3D printing: Making an architect’s dreams come true

A wide variety of different research projects are being carried out in partnership with industry at the Institute Mines Télécom (IMT) Lille-Douai. The university is currently researching the use of 3D printing for the construction industry and is taking a decisive step towards the introduction of Industrie 4.0 into the construction sector. The aim is to produce components of any shape according to digital construction plans in 3D printing. The additive production not only enables economical production in lot size 1, it is also fast and saves valuable resources.
Under the project name “Matrice”, the Institute Mines Télécom (IMT Lille-Douai) is collaborating with the Ecole Nationale Supérieure d’Architecture et de Paysage Lille (ENSAPL) to explore the possibilities of using additive manufacturing processes in the construction industry. The research project is financed by the Haut-de-France region and the European Regional Development Fund. Various industrial companies, which support the project either directly or in the form of partnerships, are also involved. Beckhoff’s contribution to the project is a PC-based control platform for the automation of the Matrice 3D printer.

Since the building industry traditionally focuses on individual designs, architecture and additive production generally go together well. Under the direction of Sébastien Rémond, professor at IMT, the Matrice project is now to provide proof of feasibility for the efficient production of concrete components in 3D printing – also with regard to series production. First, a 3D printer for components with a volume of up to one cubic meter was developed as a prototype. The aim is to explore the potential of the new process in every detail: the robot-based implementation of the printer, the use of suitable materials and the architectural load-bearing capacity. The possible range of future applications extends from model making, prefabricated parts and unique architectural elements to complete buildings produced by 3D printers.
Challenges of an interdisciplinary project

“One of the basic requirements for producing concrete components in 3D printing is the production of materials with suitable composition and qualities, especially with a view to the transition to series production,” explains Sébastien Rémond. In order to ensure stability when building an object in layers, the cement or clay-based material must exhibit very specific properties: For example, it must be liquid enough to allow pumping, but on the other hand it must not dissolve so that further layers can be applied in the continuous process.

However, research into additive manufacturing for the construction industry requires interdisciplinary cooperation between representatives from a wide variety of disciplines. Experts in chemistry, automation technology, computer science and mechanical engineering, but also in architecture and engineering contribute to the achievement of Matrice’s project goals in their working groups. The first goal is the development of a printable building material that can simultaneously perform a structural, aesthetic and thermal function and is also suitable for series production. The second project challenge is the precise implementation of the printing process according to the digital construction plan. To achieve this, the digital 3D construction plan created on the PC is divided into layers and processed by the PC-based control platform. The desired object is then created by the exact coordination of the rotary movements with the pumping and printing process. The advantages of the digitized process are on the one hand the high repeatability and on the other hand the possibility of continuous optimization through the targeted modification of individual process parameters.
Developing a suitable material composition is one of the basic requirements for the production of concrete parts in 3D printing.

Professor Sébastien Rémond adjusting the print head, which carries out the digital blueprints with the help of a robot along 4 interpolating axes in the workspace.

The IMT uses the built-in CP6203-0001-0050 Economy Panel PC with a 19-inch touchscreen as the automation platform for the 3D printer. The PC is connected with the sensors, safety devices and electronic components for controlling the motors via the EK1100 EtherCAT Coupler and various EtherCAT Terminals. This platform provides for the precise control of four interpolating axes to follow the calculated paths through the robot-assisted movement and rotation of the print head in the three-dimensional workspace. As drive components, the AXS206 Servo Drive is used in combination with AM8052 servomotors and also third-party motors.

“Another advantage of PC-based control is its modularity; this makes it easy to expand the machine by adding new components,” explains Sébastien Rémond, adding: “This project is not yet a real application, but it is a first step in development. The next step will be to design a second and larger prototype that can handle a volume of 27 m$^3$, i.e. 3 x 3 x 3 meters, and will thus be able to produce larger, but above all more complex objects.”

Further information:
www.imt-lille-douai.fr/ecole/identite
www.beckhoff.fr
Dmitry A. Dzilno elected to ETG Board of Directors

The ETG has a new member on its Board of Directors: During the SPS IPC Drives 2018 exhibition in Nuremberg, Germany, Dmitry A. Dzilno of Applied Materials was elected to the post by the assembled representatives of ETG member companies. He succeeds Erich Hutflesz, who has been active on the ETG Board of Directors since 2005. During the 13 years that Hutflesz has contributed to the development of ETG, the organization has grown from 241 to more than 5,000 members. A champion of EtherCAT since the beginning, the departing ETG board member now oversees the functional safety of hydraulic presses at Schuler Pressen GmbH – originally an EtherCAT pilot project – and is no longer available for a new term as a result. The Membership Assembly decided to honor Erich Hutflesz with an honorary ETG membership for his many years of service.

Dmitry A. Dzilno from Applied Materials (AMAT) was elected as Hutflesz’s successor on the Board of Directors. As head of control technology for the Platform Engineering Division, Dzilno recognized the exciting potential that EtherCAT offered for the semiconductor industry at a very early stage and made AMAT one of the founding members of ETG in 2003. Dzilno has been instrumental in making EtherCAT the leading fieldbus in chip manufacturing. He is currently Head of Engineering at the ALD Division as Managing Director and Senior Principal Member of Technical Staff at AMAT.

Dr. Peter Heidrich, Professor of Engineering at Pforzheim University of Applied Sciences, and Martin Rostan, Executive Director of ETG, were confirmed in continuing their roles on the Board of Directors.
ETG welcomes WITRON as 5,000th member

Intralogistics system provider WITRON Logistics + Informatics GmbH is member number 5,000 of the ETG. ETG’s strong membership growth is not slowing down even 15 years after its foundation: More than 500 new members have joined in 2018 alone.

Josef Uschold, Head of PLC Development, explains why WITRON chose EtherCAT: “For WITRON, it is essential to deploy the fastest and most deterministic fieldbus with simple configuration, installation and integrated diagnostics. The decision to select EtherCAT was the logical conclusion. Furthermore, EtherCAT is characterized by a very stable data flow and can be reliably transmitted via optical data transceivers. The technology is future-proof and the preferred standard of numerous drive manufacturers.”

WITRON is a medium-sized family-owned company based in Upper Palatinate in Bavaria, and as a general contractor, specializes in the planning and production of logistics and material flow systems. Founded in 1971, WITRON is now one of the world’s market leaders in the planning, realization and operation of highly dynamic storage and picking systems used in intralogistics applications.

ETG now offers vendor-independent diagnosis interface

Diagnostics is one of the most important functions of a modern fieldbus system. EtherCAT provides extensive diagnostic information both at the hardware and software levels. An outstanding EtherCAT feature is the ability to not only detect errors but also to precisely locate them. Furthermore, diagnostic routines test the quality of the communication and help easily detect internal errors in slaves, wrong cabling order, damaged cables or EMC interference.

The ETG has now specified a new vendor-independent diagnostics interface, which allows third-party tools to access diagnostic information from EtherCAT networks. The software-based interface can be implemented in controllers offered by any device manufacturer, which makes it an interesting feature to vendors of both master devices and diagnostic tools. The interface is easy to implement with a small software footprint, so it is even suitable for embedded devices with limited memory.

The standardized interface allows access to EtherCAT network diagnostic information for both hardware and software. Through the information provided by this new interface, diagnostic tools or HMIs can retrieve the EtherCAT network topology information, compare it with the expected configuration and detect communication interruptions and disturbances, as well as unexpected state changes.

The specification ETG.1510 “Profile for Master Diagnosis Interface” enhances the "EtherCAT Master Classes" specification and extends the EtherCAT Master Object Dictionary already defined in the "Modular Device Profile" specification. Likewise, the access mechanism makes use of the already specified Mailbox Gateway functionality. Based on already existing standards, the new profile is therefore easy and straightforward to implement.
Trade shows 2019

**Europe**

**Germany**
- Meorga Halle (Saale) 10 April 2019
- Halle (Saale)
- Automotive Testing Expo 21 – 23 May 2019
- Stuttgart
- Ligna 27 – 31 May 2019
- Hanover
- Maker Faire OWL 01 – 02 June 2019
- Herford
- Meorga Hamburg 19 June 2019
- Hamburg
- Sensor+Test 25 – 27 June 2019
- Nuremberg
- Husum Wind 10 – 13 September 2019
- Husum
- EMO 16 – 21 September 2019
- Hanover
- Meorga Ludwigshafen 18 September 2019
- Ludwigshafen
- FachPack 24 – 26 September 2019
- Nuremberg
- Motek 07 – 10 October 2019
- Stuttgart
- K 16 – 23 October 2019
- Düsseldorf
- Meorga Landshut 23 October 2019
- Landshut
- FMB 06 – 08 November 2019
- Bad Salzuflen
- Productronica 12 – 15 November 2019
- München
- SPS 26 – 28 November 2019
- Nuremberg

**Belgium**
- Bedrijven Contactdagen 04 – 05 Dezember 2019
- Kortrijk

**Denmark**
- EOT 07 – 09 May 2019
- Herning
- IOT Week 17 – 21 June 2019
- Aarhus
- HI 01 – 03 October 2019
- Herning

**Finland**
- Manufacturing Performance Days 04 – 06 June 2019
- Tampere
- Puumessut 04 – 06 September 2019
- Jyväskylä
- Alihankinta 24 – 29 September 2019
- Tampere
- Avita AudioVisual Expo 02 – 03 October 2019
- Helsinki

**Norway**
- Aqua Nor 20 – 23 August 2019
- Trondheim
- EuroExpo Ålesund 18 – 19 September 2019
- Ålesund
- EuroExpo Boda 23 – 24 October 2019
- Boda

**United Kingdom**
- Industry 4.0 Summit 10 – 11 April 2019
- Manchester
- SPE Offshore Europe 03 – 06 September 2019
- Aberdeen
- PPMA 01 – 03 October 2019
- Birmingham

**Italy**
- SPS IPC Drives Italia 28 – 30 May 2019
- Parma

**Switzerland**
- EPHJ-EPMT-SMT 18 – 21 June 2019
- Geneva

**Spain**
- Advanced Factories 09 – 11 April 2019
- Barcelona
- ITMA 20 – 26 June 2019
- Barcelona

**Sweden**
- ExpoStyr Norköping 09 April 2019
- Norköping
- ExpoStyr Örebro 10 April 2019
- Örebro

**Africa**

**South Africa**
- Africa Automation Fair 04 – 06 June 2019
- Johannesburg
- KZN Industrial Technology Exhibition 24 – 26 July 2019
- Durban
<table>
<thead>
<tr>
<th>Region</th>
<th>Event Name</th>
<th>Dates</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asia</td>
<td>InfoComm China</td>
<td>10 – 12 April 2019</td>
<td>Beijing</td>
</tr>
<tr>
<td>Asia</td>
<td>CIMT</td>
<td>15 – 20 April 2019</td>
<td>Beijing</td>
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<td>CIPM</td>
<td>17 – 19 April 2019</td>
<td>Changsha</td>
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<tr>
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<td>IAMD</td>
<td>08 – 10 May 2019</td>
<td>Beijing</td>
</tr>
<tr>
<td>Asia</td>
<td>Chinaplas</td>
<td>21 – 24 May 2019</td>
<td>Guangzhou</td>
</tr>
<tr>
<td>Asia</td>
<td>AHTE</td>
<td>03 – 06 July 2019</td>
<td>Shanghai</td>
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<tr>
<td>Asia</td>
<td>Industrial Automation Show</td>
<td>17 – 21 September 2019</td>
<td>Shanghai</td>
</tr>
<tr>
<td>Asia</td>
<td>China Wind Power</td>
<td>22 – 24 October 2019</td>
<td>Beijing</td>
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<tr>
<td>Asia</td>
<td>CeMAT Asia</td>
<td>23 – 26 October 2019</td>
<td>Shanghai</td>
</tr>
<tr>
<td>India</td>
<td>Intec</td>
<td>06 – 10 June 2019</td>
<td>Coimbatore</td>
</tr>
<tr>
<td>India</td>
<td>Automation Expo</td>
<td>25 – 28 September 2019</td>
<td>Mumbai</td>
</tr>
<tr>
<td>India</td>
<td>Engimach</td>
<td>04 – 08 December 2019</td>
<td>Gandhinagar</td>
</tr>
<tr>
<td>Israel</td>
<td>New-Tech Exhibition</td>
<td>28 – 29 May 2019</td>
<td>Tel Aviv</td>
</tr>
<tr>
<td>Japan</td>
<td>Japan Pack</td>
<td>29 October – 01 November 2019</td>
<td>Tokyo</td>
</tr>
<tr>
<td>Japan</td>
<td>IIFES</td>
<td>27 – 29 November 2019</td>
<td>Tokyo</td>
</tr>
<tr>
<td>Taiwan</td>
<td>Taipei International Automation Exhibition</td>
<td>21 – 24 August 2019</td>
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</tr>
<tr>
<td>Thailand</td>
<td>Manufacturing Expo</td>
<td>19 – 22 June 2019</td>
<td>Bangkok</td>
</tr>
<tr>
<td>UAE</td>
<td>ISA UAE Section Event</td>
<td>16 – 17 April 2019</td>
<td>Abu Dhabi</td>
</tr>
<tr>
<td>USA</td>
<td>ProMat</td>
<td>08 – 11 April 2019</td>
<td>Chicago, IL</td>
</tr>
<tr>
<td>USA</td>
<td>Seatrade Cruise Global</td>
<td>08 – 11 April 2019</td>
<td>Miami, FL</td>
</tr>
<tr>
<td>USA</td>
<td>Offshore Technology Conference</td>
<td>06 – 09 May 2019</td>
<td>Houston, TX</td>
</tr>
<tr>
<td>USA</td>
<td>Windpower Expo</td>
<td>20 – 23 May 2019</td>
<td>Houston, TX</td>
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<td>USA</td>
<td>ATX East</td>
<td>11 – 13 June 2019</td>
<td>New York, NY</td>
</tr>
<tr>
<td>USA</td>
<td>InfoComm</td>
<td>12 – 14 June 2019</td>
<td>Orlando, FL</td>
</tr>
<tr>
<td>USA</td>
<td>Pack Expo</td>
<td>23 – 25 September 2019</td>
<td>Las Vegas, NV</td>
</tr>
</tbody>
</table>

Further information:
www.beckhoff.com/trade_shows