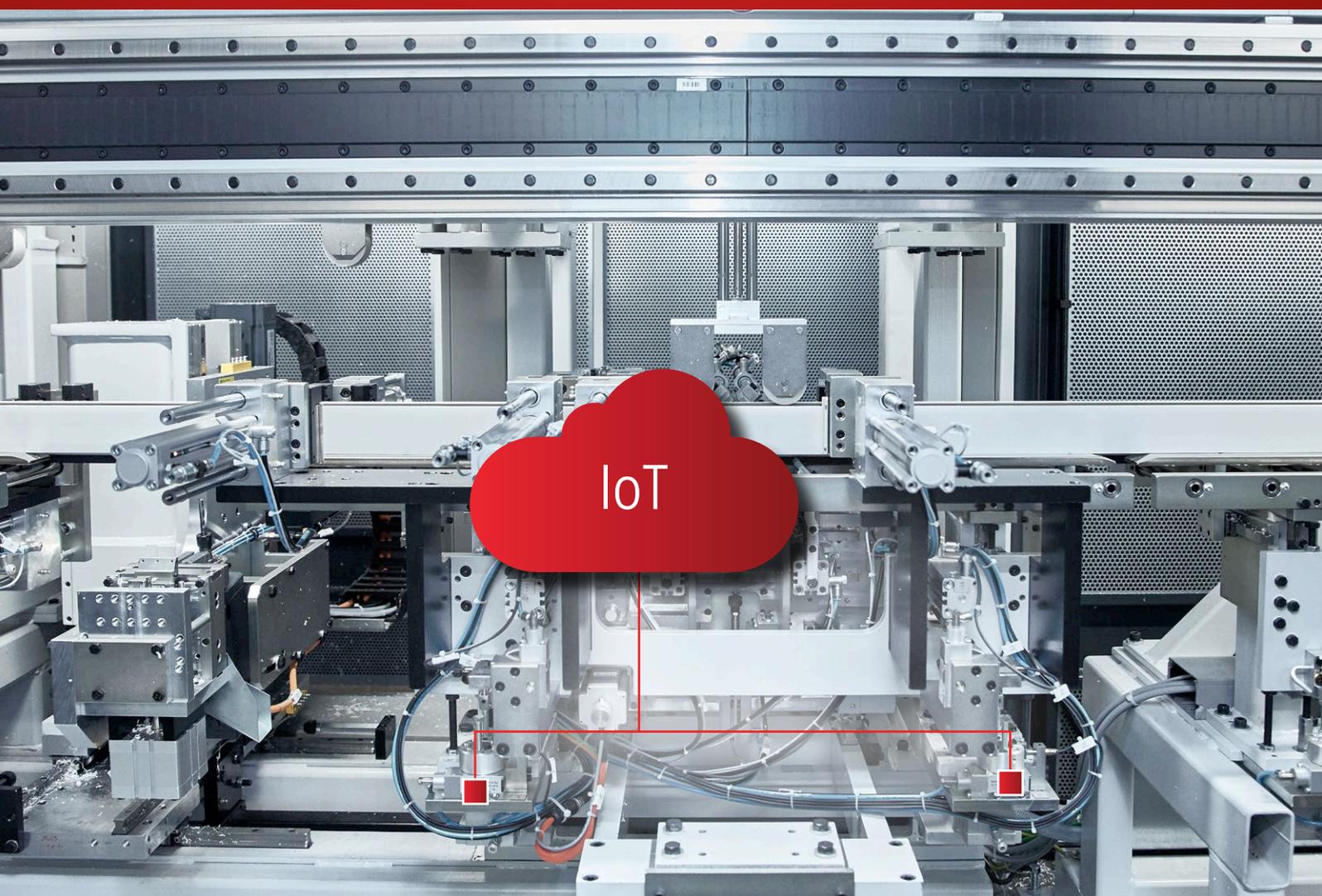**BECKHOFF** New Automation Technology

Creating value:
IoT and Data Analytics
from Beckhoff

IoT

IoT and analytics: new opportunities, new business models

PC-based control specialist Beckhoff offers the complete set of hardware and software modules for universal machine control concepts. By integrating comprehensive IoT and analysis functions, Beckhoff opens up new opportunities for machine builders to increase their competitiveness with new machine architectures. These architectures record and track the historical development of environment parameters, among others, as well as their impact on productivity. Machine builders can realize new business models and deliver machines that allow users to use comprehensive IoT concepts and cloud-based services through simple integration with freely chosen public or private clouds.

Simple IoT integration

- system-integrated with TwinCAT IoT
- cloud connection based on open standard protocols
- one engineering platform
- IoT Edge device, also for retrofits

+

Simple data analysis

- system-integrated with TwinCAT Analytics
- easy data storage and analysis
- various simple and useful algorithms
- automatic code generation
- individual analysis dashboards

=

Benefits for end users

- lower production costs
- optimized product quality
- optimized overview/transparency in production
- fewer machine downtimes
- increased productivity and availability
- cloud-based services (predictive maintenance)

Benefits for machine builders

- lower machine costs
- simple and fast diagnosis: predictive maintenance/reduced travel effort
- machine/process optimization
- new business models

The simple route from data recording to the dashboard

The Beckhoff principle is simplicity in itself: Beckhoff makes the route from data recording in the field to communication and historicisation through to data analysis in the framework of a user-specific HMI concept a comparatively simple one. IoT and data analytics scenarios can be integrated directly into existing tool landscapes and existing IT infrastructures. Sensors integrated directly with the control system are used to record data. Available fieldbuses can be used for communication, with standard protocols being used to exchange data with the cloud. Such simplicity pays off: costs, effort and training periods are reduced significantly.

Data logging

A number of different fieldbus systems can be used to record a machine's sensor data, with use of existing cabling and different topologies possible on the basis of EtherCAT.

Communication

The recorded sensor data can be communicated onward on the basis of communication standards, which can be integrated simply and secure-ly into existing IT infrastructures.

Data historicisation

The entire communication data can be stored in a long-term archive. Thus, even subsequent analyses are possible.

Analysis

The user views data and configures his analyses in the TwinCAT Engineering. From this configuration, completed PLC code can be generated.

The simple and secure route to the cloud

From IBM Watson to Amazon Web Services and Microsoft Azure through to Google IoT: users can choose their cloud service provider freely in a Beckhoff control architecture. The connection itself is uncomplicated regardless of the underlying scenario and also secure thanks to popular standard encryption. Machine and production data is forwarded to the cloud via the Beckhoff controller and TwinCAT IoT in the case of new systems, while the IPC from Beckhoff is used as an IoT Edge device in retrofit concepts. Third-party systems can also be connected in a similar manner. Direct connection from the field level is recommended for "small" IoT solutions on the basis of the IoT Bus Coupler.

new, modern machine

Communication

TwinCAT IoT

Beckhoff controller

Data logging

kWh

-3dB

Machine

aws

Azure

...

retrofit

third-party cloud enabler

plug-and-cloud

TwinCAT IoT

Beckhoff edge device

existing
Beckhoff controller

TwinCAT IoT

Beckhoff edge device

existing
external controller

IoT Device

Beckhoff IoT Bus Coupler

Simple data analysis with PC-based control

The TwinCAT Analytics concept from Beckhoff offers the possibility of selective or continuous data analysis integrated in the control system. While the TwinCAT Analytics service tool optimizes and simplifies commissioning for technicians, for instance, the Workbench offers significantly extended functionalities and automatic program code generation. The Workbench enables consistent and seamless data analysis in 24/7 use on the runtime component. Not only can machine builders offer their customers individual data analytics solutions in this way, rather also even new predictive maintenance concepts.
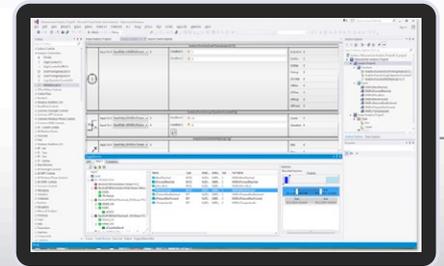
Data historicisation
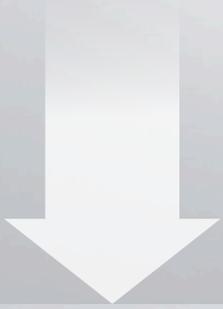
storage

Analysis

TwinCAT Analytics

analysis software for service technicians and machine builders

Dashboard

aws

△ Azure ...

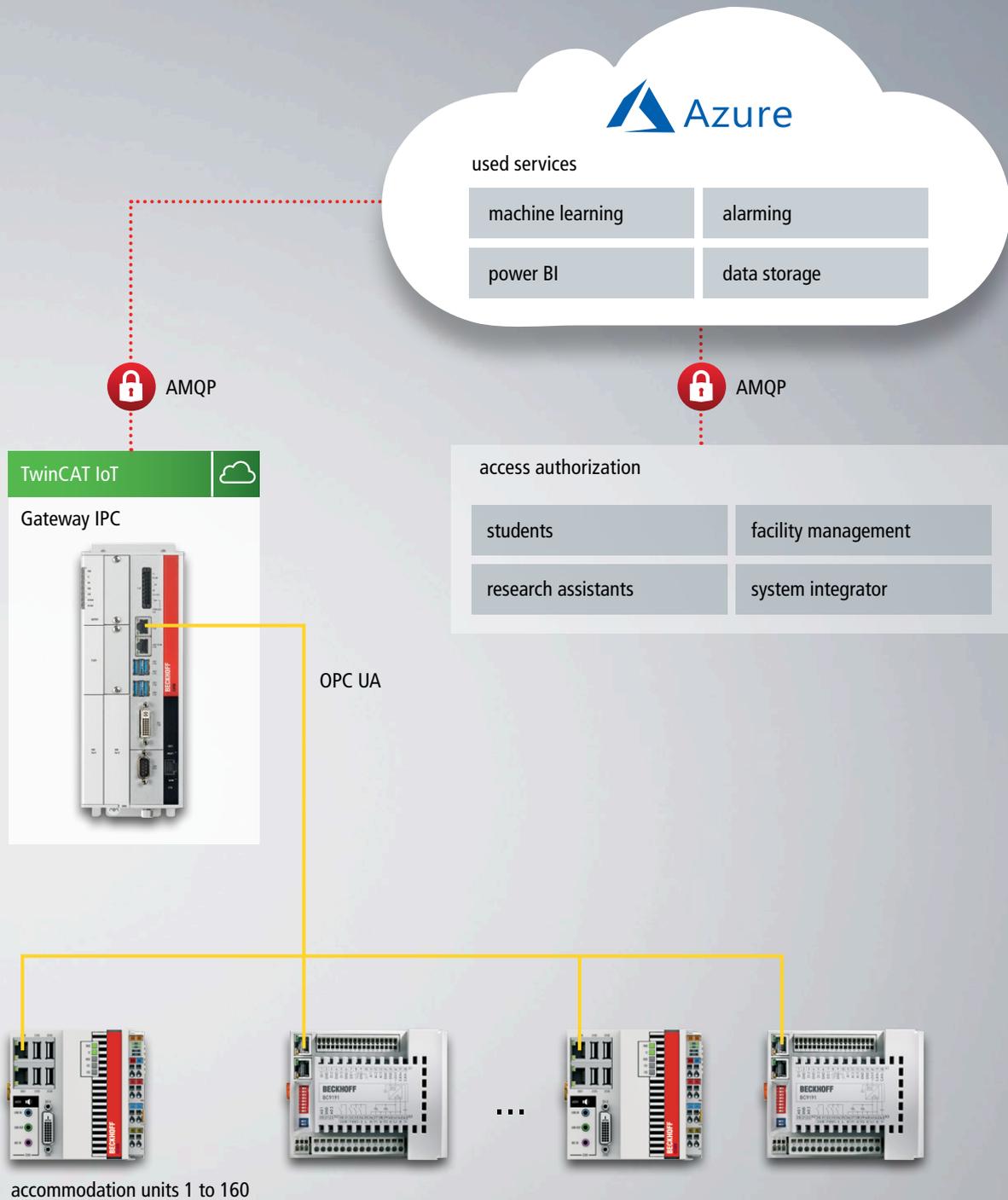easy route from the analytics tool
to 24/7 data analysis

dashboard for machine builder
and end user

IoT in use: 24/7 energy management

TwinCAT IoT was used in this application to realize a cloud-based energy management solution in the framework of a university environment. A student residence with 160 accommodation units was equipped with automation technology for recording energy consumption. The recorded energy data was transmitted to the cloud from a central gateway PC via a secure transport channel, where it was recorded, further analyzed using a range of services and made available again to different user groups. Among other aspects, students were to be given access to their own energy consumption values so they could develop efficient analysis algorithms in context with final projects.
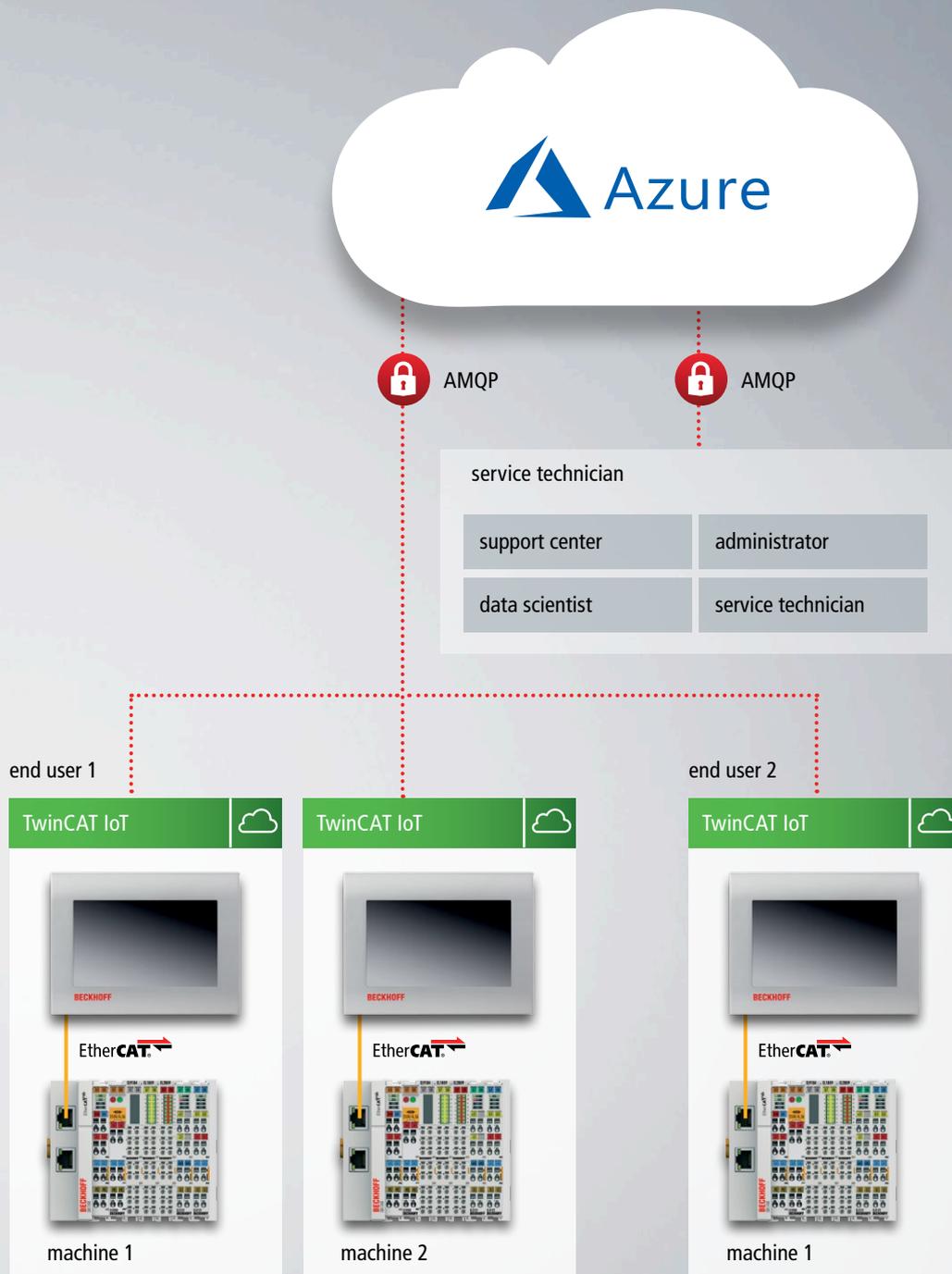
Gaining access to the energy data was also of interest for the facility management, however, for the purpose of managing and monitoring energy consumption. By using the corresponding cloud services on Microsoft Azure such management of access to the data was successfully realized.

Azure

used services

| machine learning | alarming |
| power BI | data storage |

AMQP

AMQP

TwinCAT IoT

Gateway IPC

OPC UA

access authorization

| students | facility management |
| research assistants | system integrator |

accommodation units 1 to 160

IoT in use: service on demand

TwinCAT IoT was used in this application to realize a cloud-based service-on-demand solution. Machine applications globally distributed among various end users send maintenance-related status information (e.g. on fill levels of color cartridges) to the cloud in order to secure access to data stored there for machine builders and allow benefits to be derived for different departments. Agreement was reached in the framework of a new business model based on dedicated maintenance contracts with the end users that the machine builder not only sells the machine per se, rather also assumes responsibility for maintena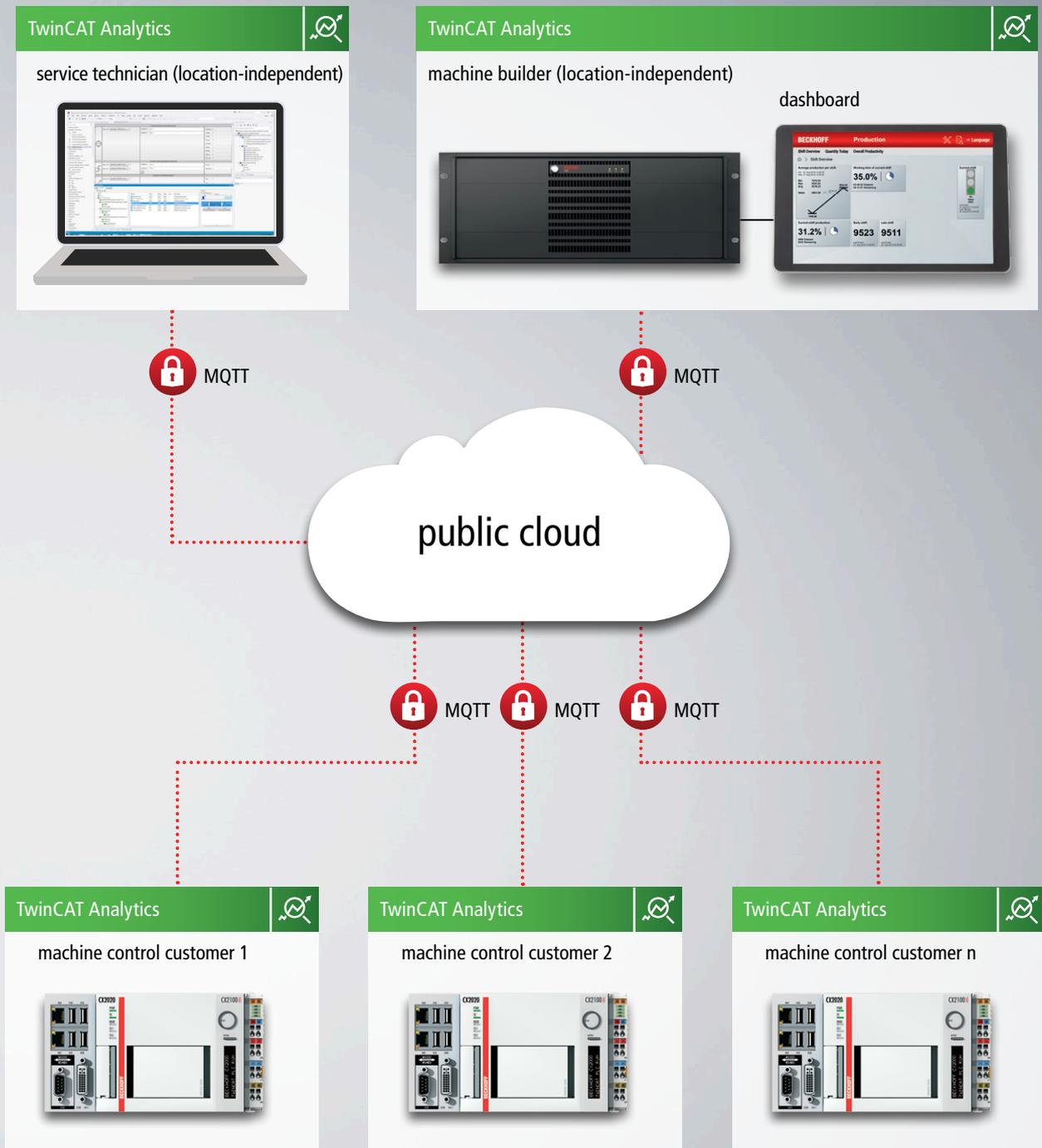nce and replenishment of all (finite) production resources required for operating the machine as part of the maintenance contract. Thanks to the availability of all of the maintenance-related status information in the cloud the machine builder knows the fill levels of the corresponding resources precisely at all times and can send out a service technician on demand to perform the replenishment – a task that needlessly had to be performed cyclically in the past without knowing the actual values.

Azure

AMQP   AMQP

service technician

support center	administrator
data scientist	service technician

end user 1   end user 2

TwinCAT IoT   TwinCAT IoT   TwinCAT IoT

EtherCAT.   EtherCAT.   EtherCAT.

machine 1   machine 2   machine 1

Analytics in use: new business models with data analysis

A machine builder would like to strengthen ties further with its customers. To do this, the machine builder offers a machine monitoring and maintenance service. TwinCAT Analytics is used to implement the solution technically. The TwinCAT Analytics Logger had been configured on the machine computers in the field for this purpose. The Logger records the process data from the machine in a precise, cyclical manner and sends it to a native MQTT message broker in a public cloud system. A data analysis was created for every machine type with the Analytics Workbench. This is used simultaneously by the service engineers in order to perform spontaneous analyses of live and historical data with the TwinCAT Analytics Service. The Workbench allows PLC code to be generated automatically from the implemented configuration, which can ensure continuous 24/7 data analysis with the installed HMI on a server IPC like the C5240 in a dedicated server room in a TwinCAT Analytics Runtime container. A ticket system informs the end user in good time as regards potential maintenance work, and indicates which tasks the end user can carry out or which require intervention by a service technician on behalf of the machine builder.

TwinCAT Analytics

service technician (location-independent)

TwinCAT Analytics

machine builder (location-independent)

dashboard

MQTT

MQTT

public cloud

MQTT MQTT MQTT

TwinCAT Analytics

machine control customer 1

TwinCAT Analytics

machine control customer 2

TwinCAT Analytics

machine control customer n

Analytics in use: local 24/7 machine monitoring

TwinCAT Analytics was used in a local network in this application to analyze an end user's heterogeneous machine pool. The end user awarded the contract for this application to a system integrator with the aim of increasing machine availability. Existing machines should not be impacted if possible. This was done successfully with the TwinCAT IoT Data Agent, with existing TwinCAT machines being queried conveniently via ADS. Data was likewise successfully transmitted directly in the case of third-party controllers via OPC UA. Additional sensors were integrated on some machines with the aid of the EK9160 Bus Coupler. Coupler and Data Agent send the data cyclically to a native MQTT message broker, which is located on a C6930. The TwinCAT Analytics Runtime component runs on this additional IPC installed in the existing network. The TwinCAT Analytics Storage Provider was used in conjunction with a Microsoft SQL database for recording the history of the data. The analysis itself was created by the system integrator with the TwinCAT Analytics Workbench on the integrator's own engineering systems. The analysis focused on monitoring the machine cycle times, the life expectancy of mechanical and electronic components as well as a quality assessment of produced goods.

end user

TwinCAT Analytics

storage

TwinCAT Analytics Storage Provider

dashboard

MQTT

local LAN

MQTT

MQTT

TwinCAT Analytics

Retrofit

ADS

OPC UA

IoT Device

EK9160 with additional sensors for machine analysis

existing machine with TwinCAT 2 controller

existing machine with third-party controller

Beckhoff offers system solutions in various performance classes for all areas of automation. The control and drive technology is highly scalable and thus optimally adaptable for different applications. The TwinCAT engineering and control software combines all required machine functions such as PLC, HMI, motion, robotics, measurement technology, vision, but also IoT and data analysis in one package. TwinCAT IoT supports all standard protocols for cloud communication and push messages to smart devices. TwinCAT Analytics provides the basis for comprehensive process data storage and analysis.

TwinCAT 3

Integration of IoT and Analytics functions into the central controller: TwinCAT integrates PLC, motion control, measurement technology as well as I/O and cloud connectivity on one software platform.

TC3
Analytics Workbench

TC3
IoT Data Agent
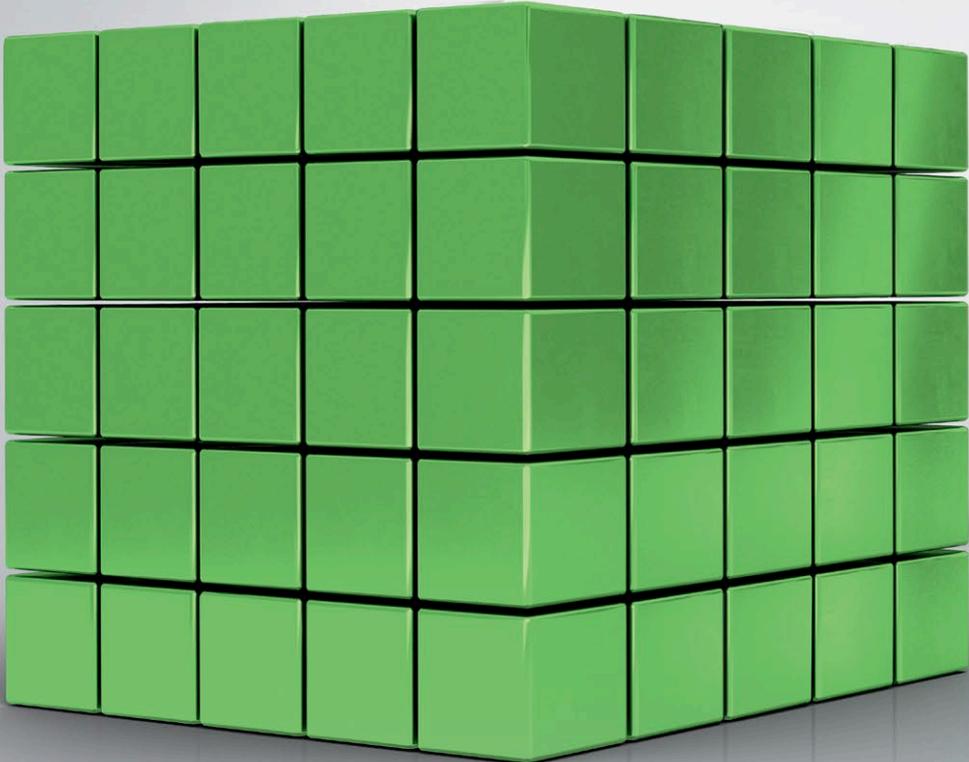
TC3
IoT HTTPS/REST

TC3
IoT Communicator + App

TC3
OPC UA

TC3
IoT Communication

TC3
Analytics Logger

TC3
Analytics Library

TC3
IoT Functions

TC3
Analytics Cloud Storage
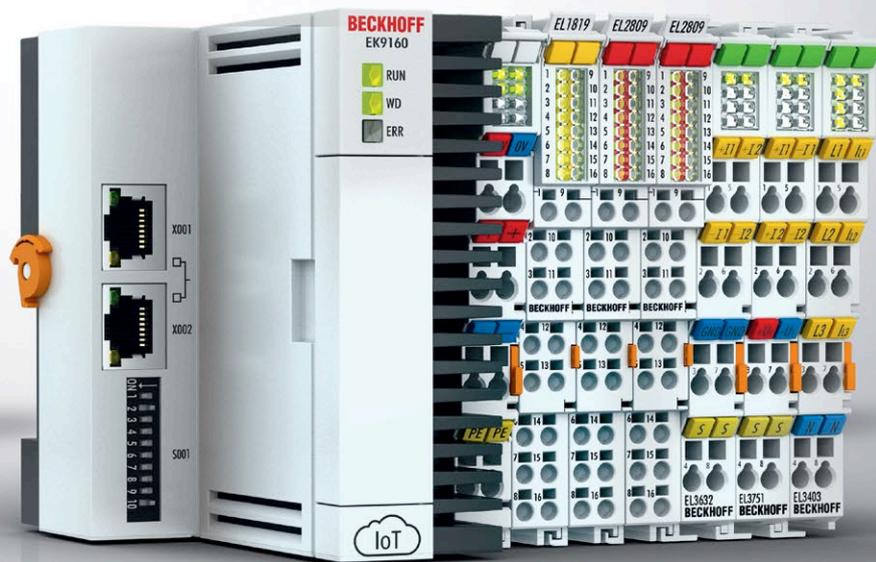
IoT Bus Coupler EK9160

IoT: products and scenarios

From a technical point of view, the Internet of Things (IoT) consists of a fast growing number of sensors worldwide, which acquire and transmit data. The term IoT furthermore also refers to the rules and actions that are applied to this data with the purpose of optimizing technical systems. Here, cloud systems provide the technological foundation for the Internet of Things and serve as a single point of contact for the devices to be connected. For all intents and purposes, a system automated with TwinCAT is able to transmit sensor and process data of new machine applications to the cloud via the TwinCAT IoT products, but also the data of older and even of third-party vendor systems.

new, modern machine

AMQP,
MQTT,
HTTPS,
OPC UA

Communication

TwinCAT IoT Communicator + App

mobile device

TwinCAT IoT Communication

Beckhoff controller
CX2000 Embedded PC with TwinCAT 3

Data logging/ machine

aws **Azure** ...

retrofit third-party cloud enabler plug-and-cloud

AMQP, MQTT, HTTPS, OPC UA

AMQP, MQTT, HTTPS, OPC UA

MQTT, OPC UA

TwinCAT IoT Data Agent

Beckhoff edge device
C6015 ultra-compact IPC

TwinCAT IoT Data Agent

Beckhoff edge device
C6015 ultra-compact IPC

ADS/OPC UA

OPC UA

existing Beckhoff controller
CX5000 Embedded PC with TwinCAT 2

existing third-party
controller
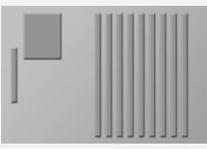
IoT Device

Beckhoff IoT Bus Coupler
EK9160

TF6720 | IoT Data Agent

The TwinCAT 3 TF6720 IoT Data Agent function is used to establish bi-directional communication services secured via TLS with cloud-based communication services such as Microsoft Azure IoT Hub or AWS IoT for instance. Services can also be connected at the same time, which are based on the MQTT communication standard. As a gateway application, the Data Agent can operate either directly on the controller or on a gateway PC and is configured by means of a graphical editor, in which the communication connections can be parameterized and the data to be communicated can be selected. TwinCAT ADS can be used as a communication protocol with the TwinCAT runtime component. Alternatively, the IEC OPC-UA standard is also available, which can likewise be used to connect a third-party device to the cloud. The Data Agent supports different sampling mechanisms for reducing data traffic and the associated costs, such as for example poll-based access to the data, OnChange notifications or also a TriggerMode, in which certain variable values can be monitored and data selected by the user transmitted to the cloud once a defined threshold is reached.

▶ www.beckhoff.com/TF6720

TF6760 | IoT HTTPS/REST

Analogous to TF6701 (MQTT), the TwinCAT 3 Function TF6760 IoT HTTPS/REST provides users with basic functions needed for sending and receiving data via the Hypertext Transfer Protocol (HTTP) in the form of a PLC library, which also supports HTTP Secure (HTTPS) communication. Acting as an HTTP client, a control system can send requests to a REST API and receive the corresponding answers. In IoT communication, an HTTPS REST API is frequently offered by web servers in order to channel certain communication process into a uniform and stateless interface. Example of use cases are the configuration of cloud services, the retrieval of weather data or the communication with messenger services.

▶ www.beckhoff.com/TF6760

TwinCAT IoT Data Agent
graphical configurator

EK9160 | IoT Bus Coupler

The EK9160 coupler connects the EtherCAT I/Os directly to the Internet of Things without a control program. It implements EtherCAT signal representation based on the IoT MQTT communication protocol and thus enables bi-directional communication of the I/O data to public cloud providers such as Microsoft Azure or Amazon Web Services. All configuration settings are made in this regard on a user-friendly website integrated on the device and can therefore be implemented without knowledge of automation.

▶ **www.beckhoff.com/EK9160**
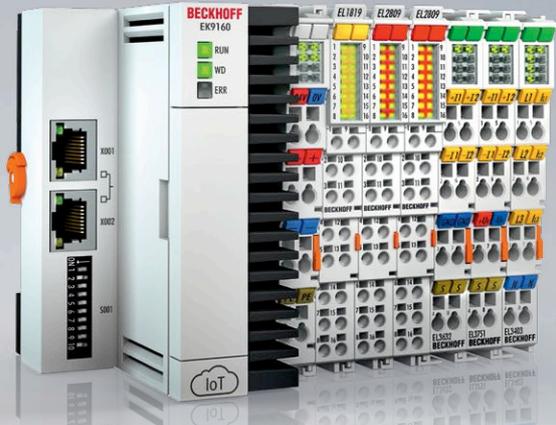
TF6701 | IoT Communication

The TwinCAT 3 TF6701 IoT Communication function provides the user with basic functions for sending and receiving data via the Message Queuing Telemetry Transport (MQTT) protocol in the form of a PLC library. This allows the PLC programmer to send and receive MQTT messages directly from/to the control system, thus enabling simple data communication between different devices. MQTT is an open and standardized message and broker-based communication protocol which, thanks to its small footprint, is becoming increasingly important in the area of fast and efficient data transmission in small embedded systems in particular. Many cloud providers offer access to their services via this protocol, though there are also message broker implementations that enable installation and operation of MQTT communication in a private cloud scenario.

▶ **www.beckhoff.com/TF6701**

TF673x | IoT Communicator + App

The TC3 IoT Communicator allows process data to be transmitted in a simple manner to any end device, state changes to be monitored and information to be communicated back to the machine. The TC3 IoT Communicator connects the TwinCAT controller to a messaging service and enables simple setup within the TwinCAT development environment for sending and receiving push messages and process data between the PLC and mobile operating systems. Every terminal is registered with a unique ID. This allows messages to be sent specifically to certain persons and/or controllers. An indicator within the message defines whether messages and status values are cached and available on demand in the messaging service. The TC3 IoT Communicator is based on outgoing connections (publish/subscribe communication) and therefore needs no special firewall settings. It can be integrated in a straightforward way into existing IT networks. Apps for receiving, transmitting and displaying these messages are available in the app stores for free download.

▶ **www.beckhoff.com/TF6730**
▶ **www.beckhoff.com/TF6735**

TF6710 | IoT Functions

TwinCAT 3 TF6710 IoT Functions allows communication connections to be established with cloud-based communication services. Various PLC function modules are available to the user in this context in order to send process data simply from the TwinCAT runtime component to the respective cloud service or to receive data from the service. TwinCAT IoT Functions uses the protocol and service implementation of the TwinCAT IoT Data Agent (TF6720) in this context and can thus be regarded as the PLC variant of the Data Agent.

▶ **www.beckhoff.com/TF6710**

Benefits of TwinCAT IoT:
- simple and secure connection with cloud systems
- based on standardized communication protocols
- retrofit scenarios for older machine applications possible
- products for the integration of third-party devices into the cloud available
- smartphone app for mobile machine connectivity available

Benefits of EK9160:
- simple and secure connection with cloud systems
- easy web-based configuration
- easy configuration, no programming skills required

Analytics: products and scenarios

How can you gain competitive advantages in common IoT and Industrie 4.0 environments? On the one hand through better, more precise and significant data, but above all through fast, valid data analysis and appropriate rapid reaction. This explains why an increasing number of data analysis tools are finding their way onto the market. Yet for the most part these do not speak the language of the machine builder and are limited conceptually to a small few scenarios. TwinCAT Analytics, in contrast, has been developed specially for this sector. The new TwinCAT Analytics engineering tools are integrated seamlessly into the Microsoft Visual Studio® environment that is already familiar from the machine applications. This means considerable time savings for the analysis application since no extensive training is needed. Moreover, many algorithms are available, which have been specially developed in a language that allows direct reference to mechanical engineering and the relevant application. Interaction with familiar tools from the TwinCAT product world, such as the TwinCAT Scope charting tool, simplifies use of the new opportunities that TwinCAT Analytics offers. TwinCAT Analytics is not just limited in this sense to spontaneous troubleshooting on machines, rather allows permanent 24/7 monitoring of one

or more machines located in a network. The way to 24/7 monitoring is very simple, since readable PLC code along with an HTML5-based analysis dashboard can be generated at the touch of a button from an analysis created in the configuration tool. Once created, an analysis can run in parallel with the machine application either on an IPC or on a virtual machine in a cloud system as well as in TwinCAT Cloud Engineering. Two completely transparent projects are created for both the PLC and the HMI. For individual analysis requirements, both projects can be modified and extended by means of commonly used programming languages. Existing code

can simply be transferred without any changes. If you want to provide the generated analytics dashboards to the end users as added value, you can select specific header colors, company logos and layouts beforehand. It goes without saying that TwinCAT Analytics not only works with live data, but also with historical machine data. This functionality is covered by the Analytics Storage Provider, which can access various storages and databases. The user no longer has to define the table architecture in this scenario, since the Storage Provider does this automatically in the background and even access to the data does not require special knowledge of SQL commands,

either for reading or writing. Everything can be operated in TwinCAT Engineering via the Target Browser as it is known. It is therefore clear that TwinCAT Analytics is not just a product, rather an entire workflow that allows the application to be written for the 21st century with the aid of structurally flexible IoT technologies.

Analytics: products and scenarios

In all TwinCAT Analytics applications, communication is key. IoT technologies offer excellent flexibility and performance. With data sources acting as MQTT clients, you can use the TwinCAT 3 Analytics Logger directly in real time, or the IoT Data Agent as a gateway application that connects existing TwinCAT or third-party devices via ADS or OPC UA. Added to this is the EK9160 EtherCAT Coupler, which publishes input data directly on an MQTT endpoint. Service technicians can either spontaneously access data live or via storage query. A continuous 24/7 analysis application is equally possible for all data sources.

Analytics

TwinCAT Analytics Service Tool

TwinCAT

storage

TwinCAT Analytics Storage Provider

MQTT

mess

MQTT

Beckhoff

TwinCAT

C7015 ultra-c

ADS/OPC UA

Beckhoff controller

TwinCAT Analytics Logger

CX2000 Embedded PC with TwinCAT 3

existing Beckhoff controller

CX5000 Embedded PC with TwinCAT 2

Dashboard

Analysis

PLC code generation

dashboard code generation

C6030 ultra-compact IPC

Analytics Runtime

TwinCAT Analytics Workbench

MQTT

Data historicisation

sage broker

MQTT   MQTT
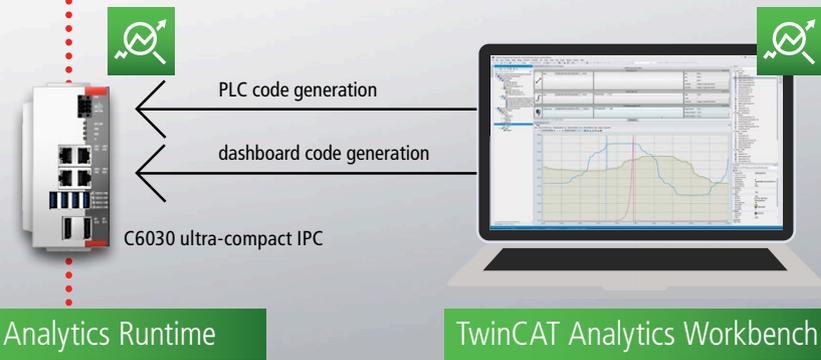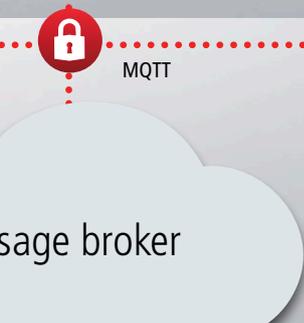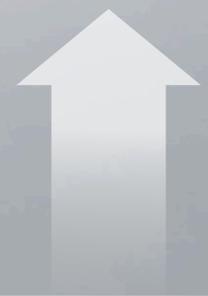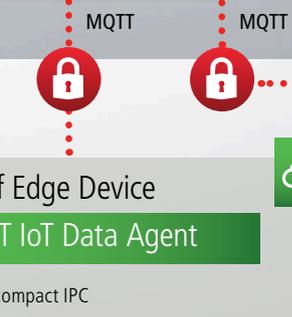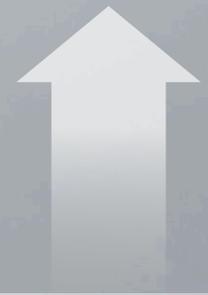
Communication/
data logging

f Edge Device

T IoT Data Agent

ompact IPC

OPC UA

existing 3rd-party
controller

Beckhoff IoT Bus Coupler

IoT configurator

23
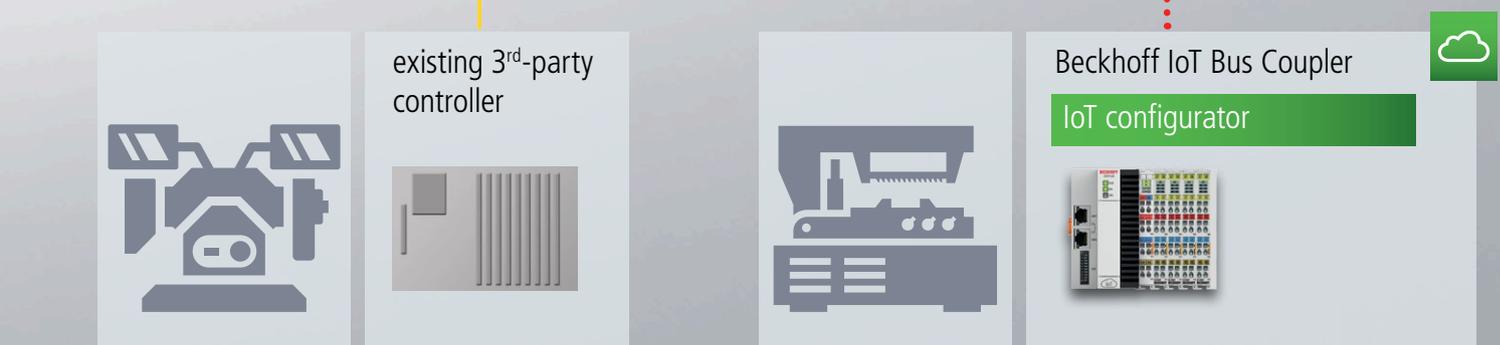
TE3520 | TC3
Analytics Service Tool

The TwinCAT Analytics Service Tool is ideal for commissioning the machine and for service engineers. Live and historical data can be retrieved for an analysis via the IoT connection. Moreover, binary files created on the machine computer by the Analytics Logger can also be analyzed. The analysis is configured in Microsoft Visual Studio® where the user has easy access to a toolbox of algorithms for implementing the relevant life time, cycle time, envelope or component counter analysis. The outputs of the algorithms can be used as inputs for other algorithms or can be output as a result directly in the graphical editor. Signal paths can be visualized with ease by means of parallel recording with the TwinCAT Scope charting tool familiar from the TwinCAT world. Analysis results can be dragged by the user from the analytics configurator and dropped in the charting tool so as to mark the significant positions in the data stream. These can be simple minimum and maximum count values but also results of the logic operator, for instance, which can be used to logically link events from the machine controller and thus retrieve them again in the data stream. This allows correlation with other signals in the Scope View in a precise cyclical manner. The interaction between the product components offers advantages in particular for diagnosing machine behavior and can highlight optimization potential. The user's location is immaterial owing to the IoT technologies used, which means that service technicians can perform system and machine diagnostics from practically any location.

▶ **www.beckhoff.com/TE3520**

TE3500 | TC3
Analytics Workbench

The TE3500 Analytics Workbench engineering product allows continuous data analysis based on multiple and spatially distributed sources. A large number of useful analysis algorithms can be used very simply with drag & drop in a graphical editor in order to create an individual analysis configuration. The key aspect in this regard is the intuitive usability of the configurator, which is integrated in Microsoft Visual Studio® as a TwinCAT-independent project. The presentation of the algorithms is split strictly into three areas, i.e. inputs, parameters and outputs. The MQTT input data is selected via the TwinCAT Target Browser, with live data and historical data available via the Analytics Storage Provider. Following configuration, which can be structured very clearly even across different networks, the results can be displayed directly in the graphical editor. Once the prepared analysis is complete and tested, this configuration can be converted to readable PLC code and a corresponding HTML5-based Analytics Dashboard. The automatically generated PLC code can be downloaded directly onto a device with TF3550 or TF3551 Analytics Runtime and operated there 24/7 in parallel with the actual data source, i.e. the production machine, and supply analysis results. The structured text generated can of course be enhanced individually by the application developer. Ultimately, this is a programming language that is already known to the user from the respective machine application. The use of Beckhoff standard PLC libraries is possible in this context too. The libraries from the TC3 measure-
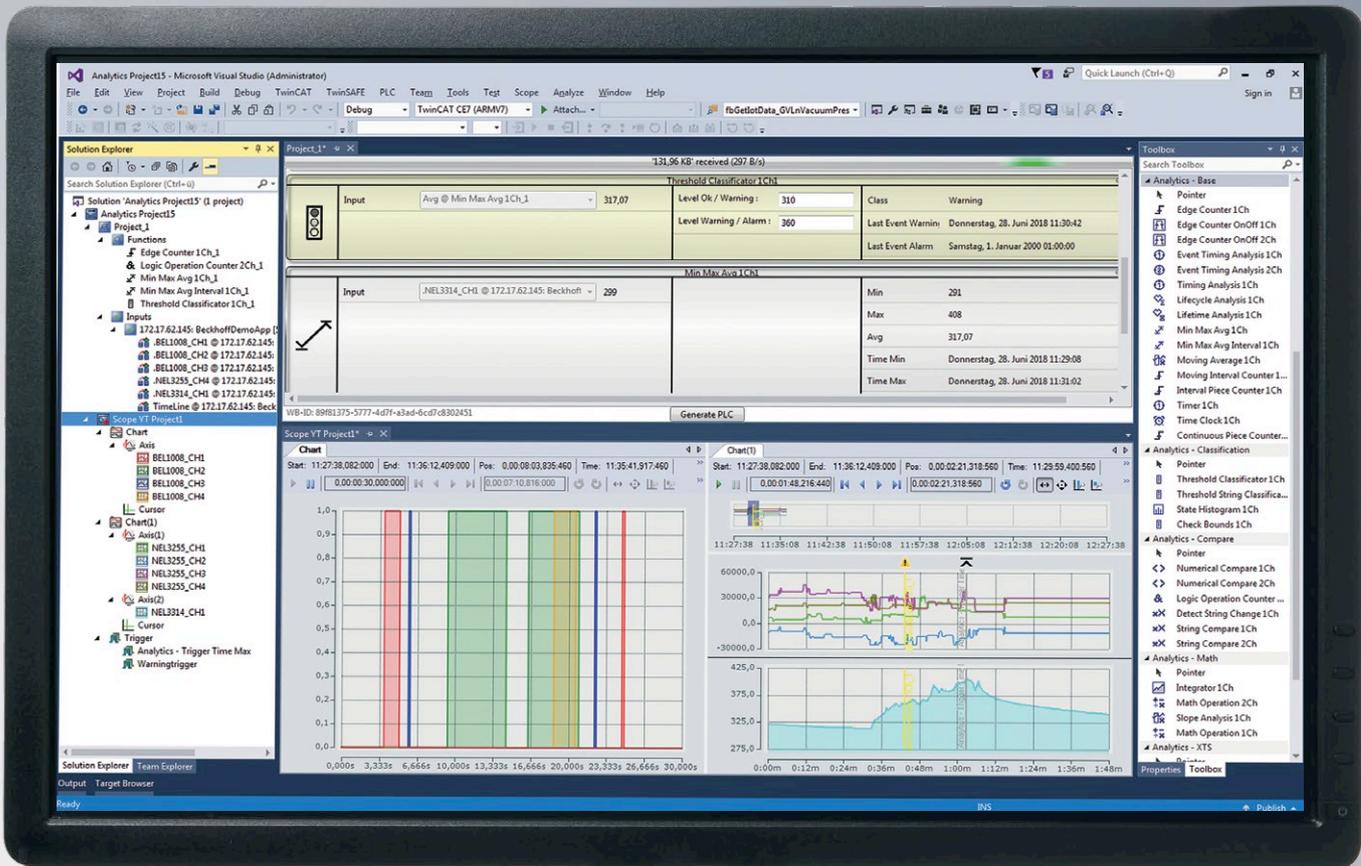
Configurator for the evaluation of historical data within Analytics Workbench

ment area are especially suitable in this regard for extending the analytics functions, for example the Condition Monitoring library. Thanks to these features, the Analytics Workbench supports machine builder and producers of automation technology in particular in realizing IoT projects in a straightforward manner. MQTT-based data communication allows the data to be processed and used independently of location. The dashboard based on the TwinCAT 3 HMI can also be customized. On the one hand, through many options offered by the so-called Deploy Wizard, and on the other hand, through a Mapping Wizard, which makes

it possible to integrate your own HMI framework controls into the dashboard generation process. In addition, this HMI code is also not a black box and can be edited with the TwinCAT HMI engineering tools. This allows you, for example, to define access authorizations for different target groups: for machine operators, production managers or the machine builder's service technicians. Ultimately, the Analytics Workbench enables the implementation of new data-based business models.

▶ www.beckhoff.com/TE3500

Core benefits of Workbench and Service Tool:

- **Expanded offers:** development of new business models through data analysis
- **Time savings:** a faster route to individual IoT analytics applications with automatic PLC code and HMI dashboard generation
- **Simplified engineering:** benefits of familiar software development environment and the standard tools from the TwinCAT system
- **Increased flexibility:** TwinCAT IoT runs locally on the machine, in the network or in the private or public cloud

TwinCAT Analytics: all products at a glance

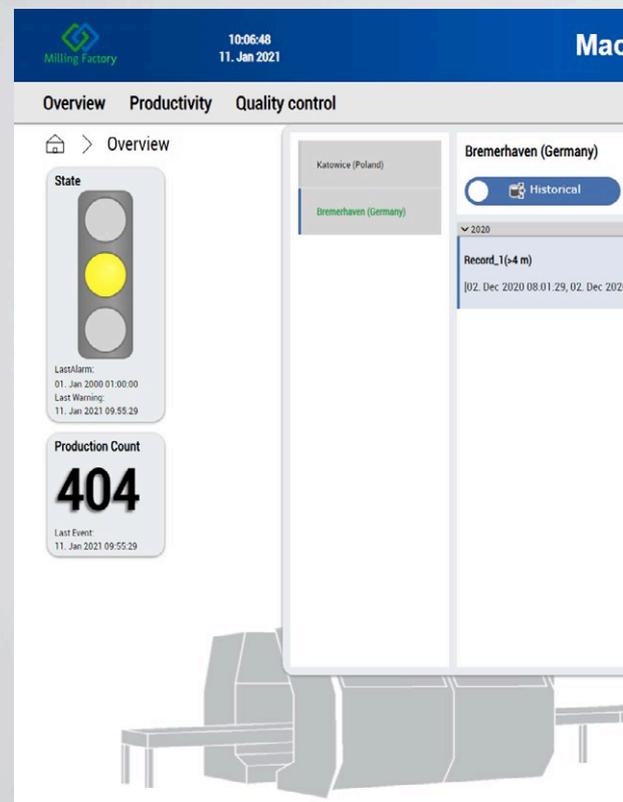Generated dashboard in dark theme with trend line chart and dock

TF3550 | TC3 Analytics Runtime

TwinCAT 3 Analytics Runtime is the product for continuous data analysis and its representation. With the help of the Analytics Workbench, 24/7 monitoring of machines and other applications can be realized very easily. The automatically generated PLC code and the generated HMI dashboard can be downloaded to the Analytics Runtime. This type of container can be implemented locally, on remote hardware or in a virtual machine. The core of the product is a classic PLC runtime environment, which thus offers the same robustness as the machine applications themselves. Furthermore, the runtime includes the TwinCAT HMI Server for displaying the analytics dashboard with many standard or individual controls for the algorithms. In summary, the Analytics Runtime is a bundle of different licenses. Included are, in addition to the PLC Runtime and HMI Server, the Analytics PLC library with many algorithms, the PLC library for storage provider connectivity, IoT connectivity with MQTT and HTTPS/REST, and the HMI Client Pack 3 allowing multiple users to view a designed dashboard at the same time. An extension with further single licenses is possible at any time, for example, to realize a database connection or to use further algorithms in the PLC.
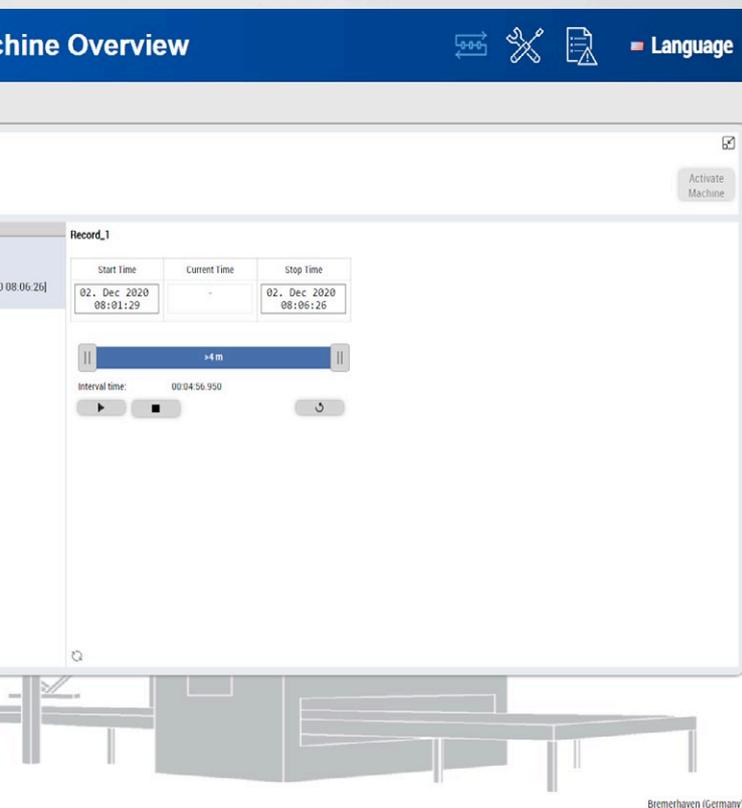
▶ **www.beckhoff.com/TF3550**

Automatically generated dashboard with data source multiplexer and switchover to historical data

...ked traffic lights on the side that shows the same overall system status across all pages
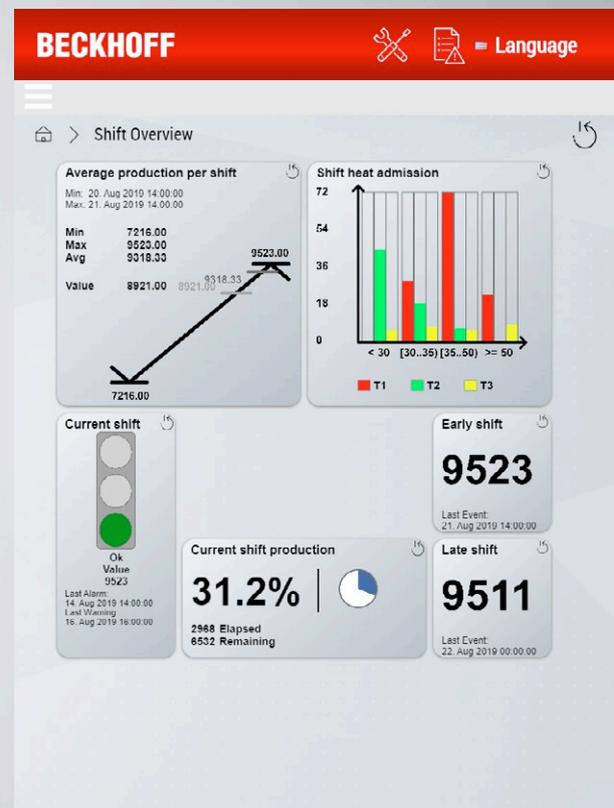
Dashboard in light theme with activated reset button
for the algorithms and the overall site

TF3500 | TC3
Analytics Logger

The TwinCAT 3 Analytics Logger records process and application data of the machine controller in synchronization with machine cycles. The logger is characterized by its high performance as it operates directly in the real-time context of the TwinCAT controller. The recorded data can optionally be stored locally in a file on the hard disk of the machine controller and played back with ring buffer functionality or transmitted to a message broker by means of the IoT communication protocol. The configuration required in this instance is performed conveniently in the familiar TwinCAT 3 engineering environment in Microsoft Visual Studio®. All variables of the process image and the PLC application can be added easily to the configuration via a check box without the need for programming.

▶ **www.beckhoff.com/TF3500**

TF3510 | TC3
Analytics Library

The TwinCAT 3 Analytics Library is a PLC library with numerous analysis functions and application data. The library can be used locally on the machine controller or on a remote analysis system with IoT communication connection. Function modules are available with simple and more complex functions. The spectrum ranges from flank counters, life time monitoring, machine cycle analysis through to mathematical functions and envelope curve monitoring. Minimum and maximum input signal values can be calculated in just the same way and linked together by means of logical operators. All modules are suitable for object-oriented application design and use the latest features of IEC 61131-3 programming.

▶ **www.beckhoff.com/TF3510**

TF3520 | TC3
Analytics Storage Provider

The TwinCAT 3 Analytics Storage Provider is an IoT client and forms the interface to one or more storage facilities for raw and analysis data from various sources. The data is stored as a binary blob in the storage medium. Microsoft Azure Blob supports a public cloud, while Microsoft SQL supports an on-premises database. In this way, both applications can be covered. The user does not have to worry about structuring and storing the data; the Analytics Storage Provider does this automatically. The storage interface can be easily configured via TwinCAT Engineering in Visual Studio®. Data is selected centrally for reading and writing via the TwinCAT Target Browser. The user selects the data via the user-defined variable name in the machine application and the corresponding time period; no complex SQL commands are required. Historical data can be sourced via Analytics Logger, IoT Data Agent, EK9160 or the Analytics Workbench.

▶ **www.beckhoff.com/TF3520**

Several records can be managed parallel with the Analytics Storage Provider

TF3551 | TC3 Analytics Runtime Base

TwinCAT 3 Analytics Runtime Base is the container in which the analytics application generated by the Analytics Workbench runs. This application can continuously analyze data acquired from machines in the field. The runtime can be installed locally, on remote hardware, or on a virtual machine. It is the ideal product if you want to run an analysis in headless mode or when a customer-specific visualization is already available. Such a dashboard can then access the analysis data with the familiar connectivity tools provided by TwinCAT. In summary, Analytics Runtime Base is a bundle of different licenses. Included is a PLC runtime, the Analytics PLC library, the Storage Provider library and the IoT connection.

▶ **www.beckhoff.com/TF3551**
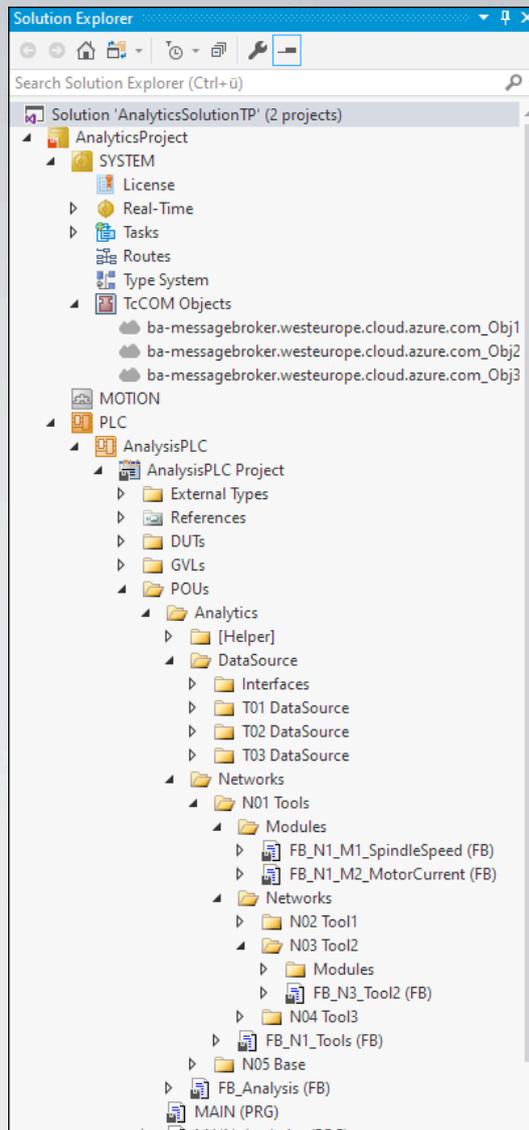
Automatically generated PLC analysis code for the Analytics runtime

Core benefits of Runtime, Library, ASP and Logger:

- **Reduced costs:** Attractive license packages for mapping the complete workflow
- **Time savings:** Configuration rather than programming
- **Easier handling:** Algorithms for machine builders and automation specialists and virtually automatic data storage
- **All operating options:** Implementation of online scenarios with IoT technologies or collection and analysis of offline data

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