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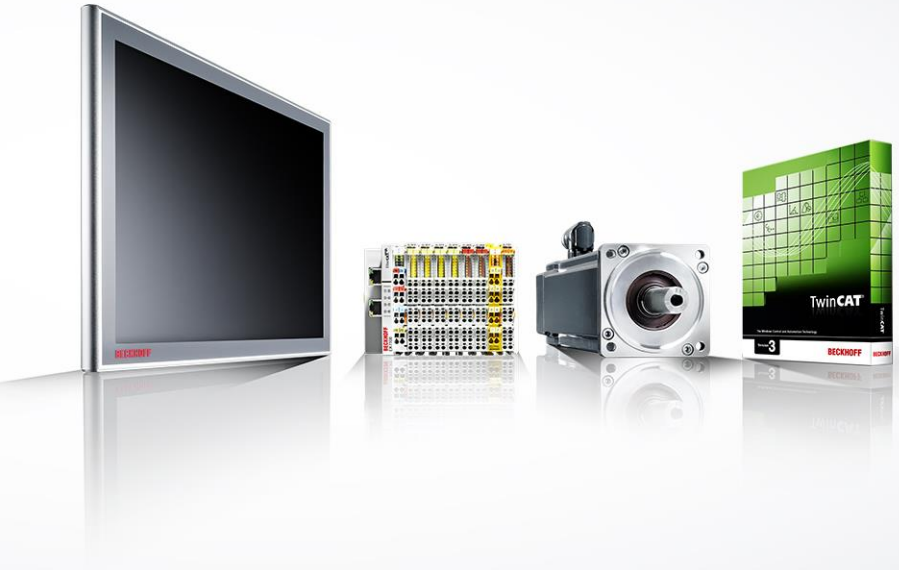
TwinCAT 3

Leading Edge Automation Technology



Josef Papenfort
TwinCAT Product Management

Agenda

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1. TwinCAT 3
   - Modular Software for modular machines
2. TwinCAT Analytics
3. Summary

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1. **TwinCAT 3**
   - **Modular Software for modular machines**
2. TwinCAT Analytics
3. Summary

TwinCAT 3 – Modular Software Architecture

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Modular Runtime
Configuration instead of programming

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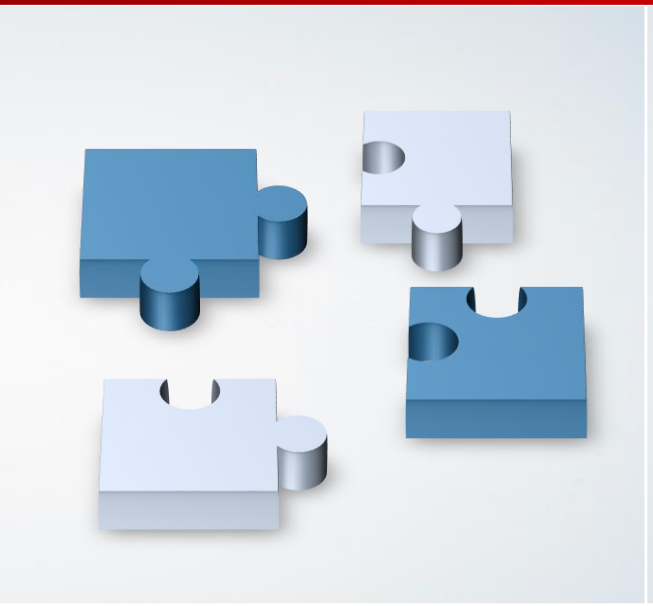


- Independent teams of developers
- can use different programming languages
- when they collaborate to build functionalities
- Can be binary deployed

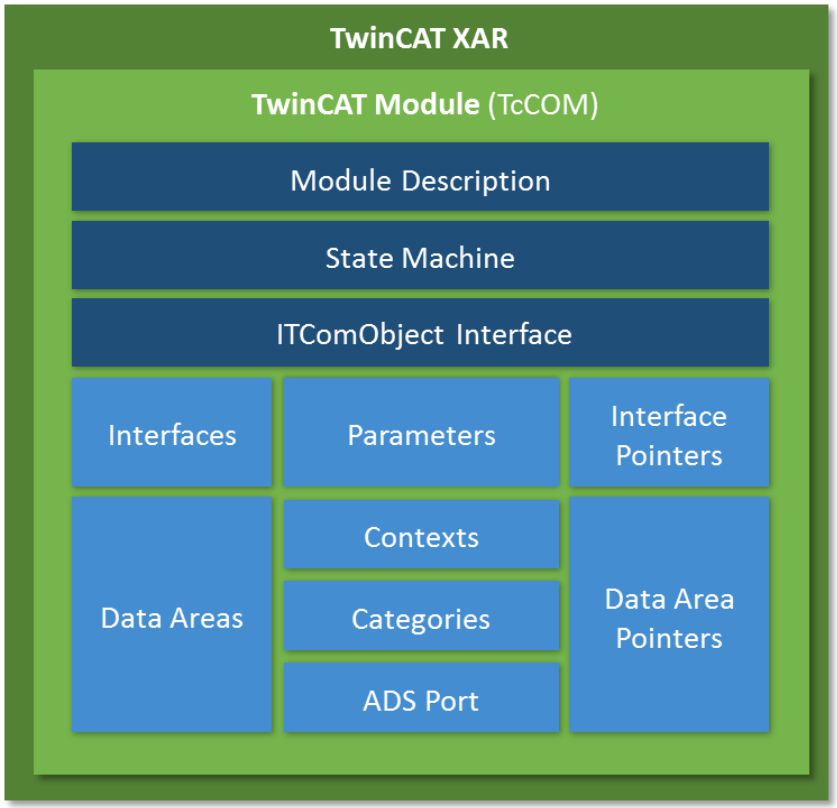
- Then the modules can be simply combined and configured …

- to generate the application.

Modular Runtime Interface

TwinCAT Component Object Model (TcCOM)

- Separation of encapsulated functionality into modules
- Scalability: Modules can contain simple functions, complex algorithms and real time tasks or complete projects
- Goal: Easy reusability of modules
- Standardization:
  In interfaces and in behavior
- Cooperation: Modules can be written in
  - IEC 61131-3
  - C/C++
  - MATLAB Simulink



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1. **TwinCAT 3**
   - **Scalable in software and in hardware**
2. TwinCAT Analytics
3. Summary

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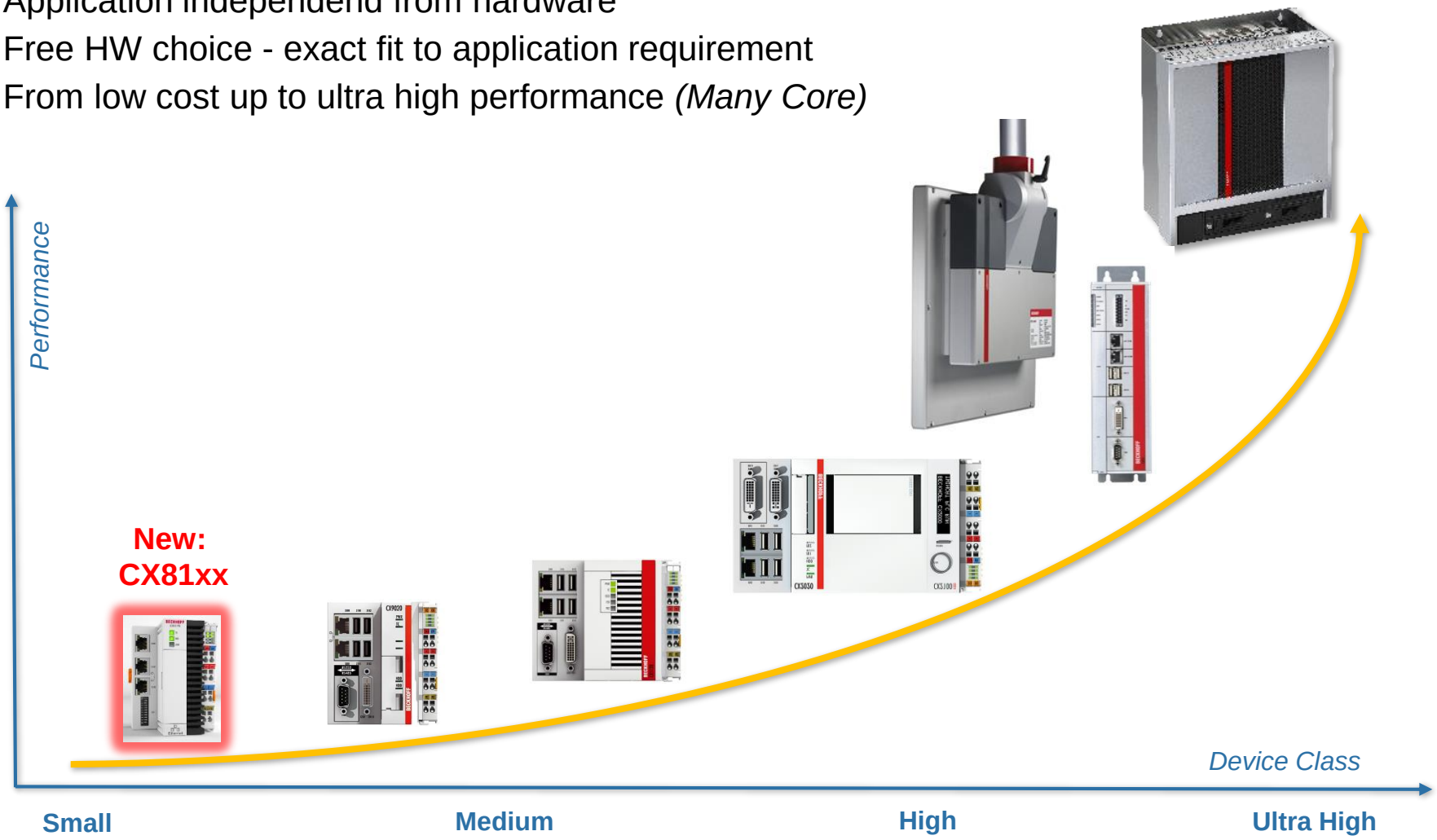
High Scalability

- Application independend from hardware
- Free HW choice - exact fit to application requirement
- From low cost up to ultra high performance *(Many Core)*



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1. **TwinCAT 3**
   - **Supporting Standards**
2. TwinCAT Analytics
3. Summary

Support of Open Standards

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Using Standards

- Hardware: Intel processors – newest generation
- Microsoft OS – worldwide accepted
- Microsoft Visual Studio for Engineering
- IEC61131-3 – standard for PLC programming
- PLCopen standard for Motion, Connectivity, Safety
- C++ - the standard in IT
- MATLAB/Simulink – the standard in science
- Safety – integrated

- EtherCAT and 12 other fieldbus systems
- IEC62541 OPC-UA – communication standard
- IEC61850 / IEC60870 – telecontrol protocols
- BACnet – the standard for communication in BA

Windows Embedded Standard 7

OPC FOUNDATION

EtherCAT

Microsoft Visual Studio

IEC

intel

PLCopen safety

MATLAB Simulink

PLCopen Benchmarking

ASHRAE BACnet

PLCopen motion control

PLCopen ERP MES HMI IEC 61131-3 C T R L OPC UA

Agenda

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1. **TwinCAT 3**
   - **Effective Engineering**
2. TwinCAT Analytics
3. Summary

TwinCAT 3 framework = Microsoft Visual Studio 201x

- Usage of the most common programming environment
- Extendable via PlugIns
  - Add the TwinCAT Plugins into the Visual Studio
  - Visual Studio is prepared for this!
- Link to common source control software
  - All common tools are supported, like TFS, SVN (mercurial, GIT..)
- Usage of C und C++ for programming automation devices
  - Beckhoff does not want to develop a C++ programming environment
- Usage of .NET languages for none real time applications (e.g. HMI)
- Improved help system
- Support from Visual Studio 2010 to actual Visual Studio 2015!
- And: supported by Microsoft!

Engineering (XAE)

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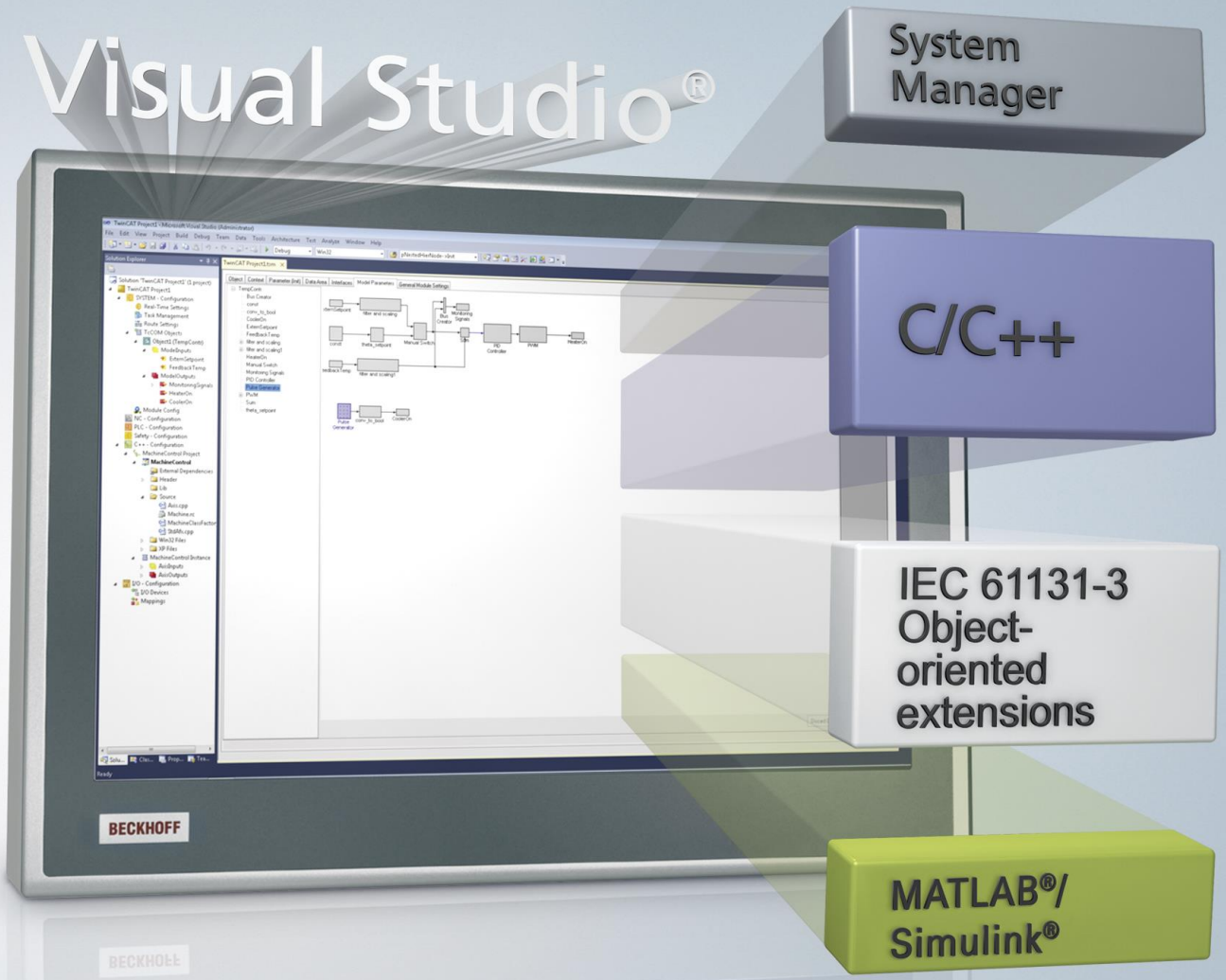
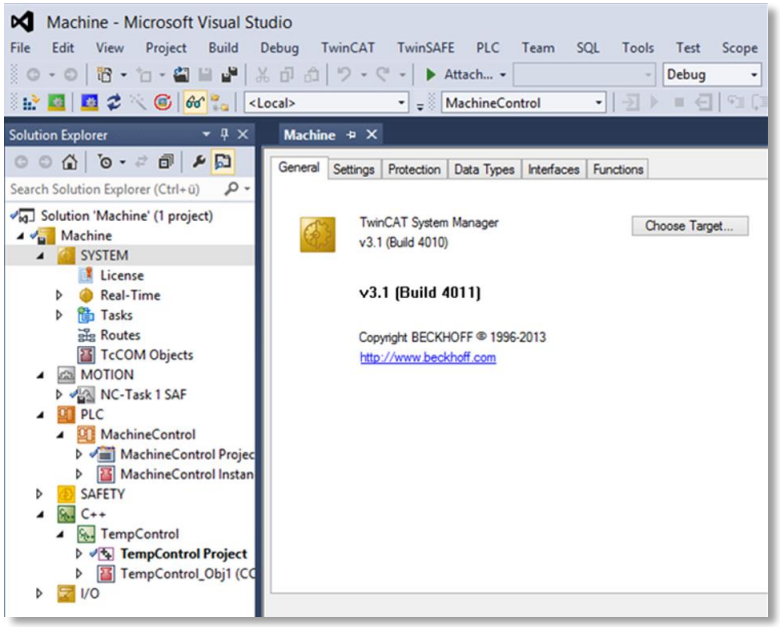


Integrated System Manager

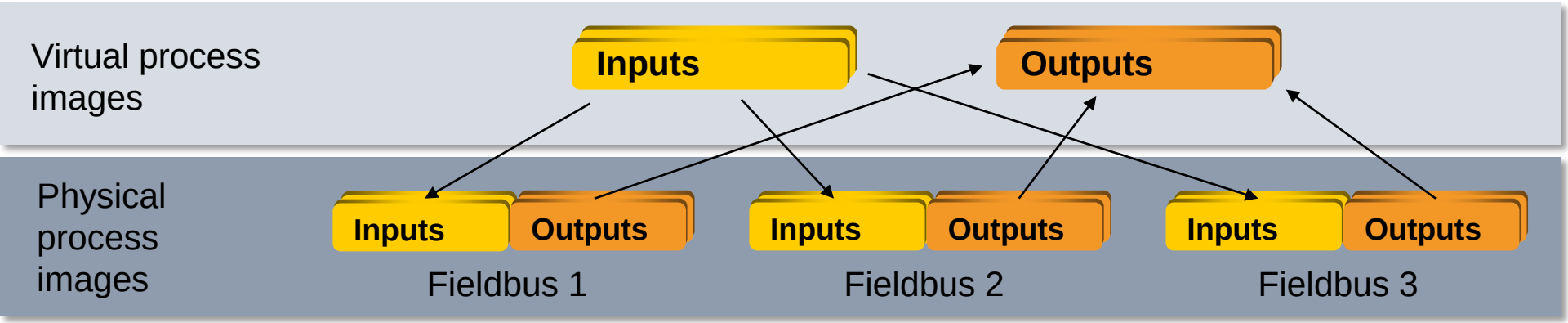
- Programming, configuration and diagnostics in one tool
  - continuous development since 1996
- Configuration of system, fieldbus, motion, Safety, PLC/C++
- Uniform task management
- Datatype management between C++/MATLAB Simulink, IO and PLC
- Parameterisation of TwinCAT modules
- Creation and management of mappings between the process images
- Simulation of I/Os and axes



Mapping between process images

- Open for all known fieldbuses
- Simple commissioning and diagnostics
- Separation into logical and physical process images

  → Change of the bus system does not require a change of the PLC/C++ code



DeviceNet · USB · CANopen · RS 232 / RS 485 · sercos international · INTERBUS · PROFIBUS · EtherNet/IP · Modbus · LIGHTBUS · ControlNet · EtherCAT

Language Support

- Support of IEC61131-3 third edition, all languages
- Support of C/C++ for object oriented IT audience
- Support of MATLAB/Simulink
- All of them can interact with each other !

→ Select the best language for your application

```
52  IF AutoPos >= 200 AND AutoPos < 370
53      MotorUeberlast := TRUE;
54  ELSE
55      MotorUeberlast := FALSE;
56  END_IF
```

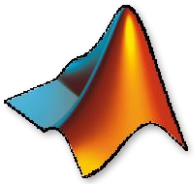
PLC with IEC61131

```
//////////////////////////////////////////////////////////////
// ITcCyclic
HRESULT CMyModule::CycleUpdate(ITcTask* ipTask, ITcUnknown* ipCaller, ULONG context)
{
    HRESULT hr = S_OK;

    // TODO: Replace the sample with your cyclic code
    m_counter+=m_Inputs.Value;
    m_Outputs.Value=m_counter;

    return hr;
}
```

C/C++



MATLAB Simulink

Object orientation according to IEC 61131-3 3rd Edition

Goal: Programming (of machine functions)

Features

- as simple as possible
- fast and efficient
- easily reusable modules

In operation

- easy maintenance

Benefits of OOP

- enhanced transparency
- structured code
- enhanced reusability
- reduced engineering times
- reduced engineering costs
- enhanced readability
- enhanced expandability

Benefits of the object oriented extensions

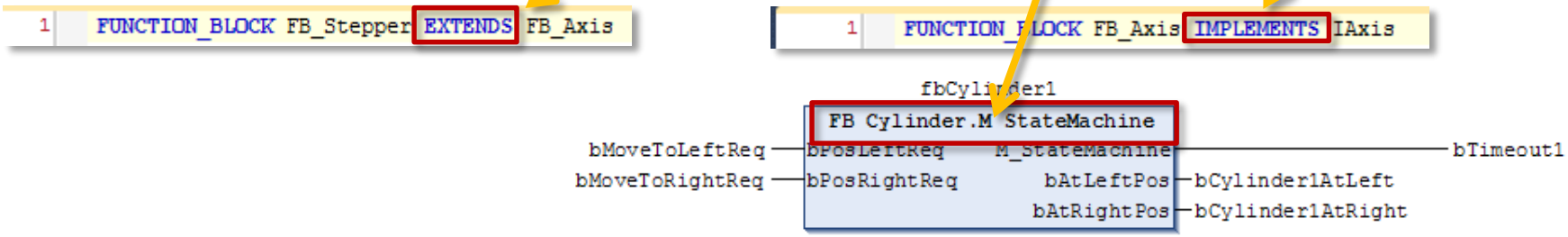
- Increased readability of the code by encapsulation algorithms into methods
  → Increased maintainability
- Modularization, structuring of the code
  → Increased reusability
- Abstract programming by using interfaces
  → Increased extensibility and adaptability
- Construction of inheritance hierarchies
  → Increased extensibility and adaptability

Consistent usage of the object oriented extensions enables:

- Increased software quality
- Decreased time for programming and maintenance

Object oriented extensions of the IEC 61131-3 3rd edition

- Concept of the function blocks was extended by
  - Classes
  - Interfaces
  - Methods
  - Inheritance
  - Properties
  - Keywords THIS, SUPER



- Usage of the extensions
  - Is possible in all IEC languages
  - Independent from the used hardware
  - **Not mandatory**

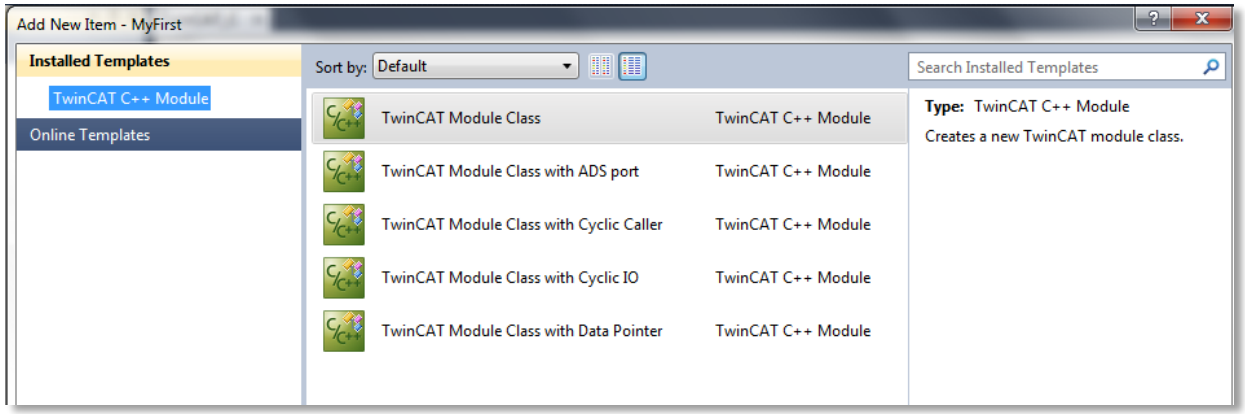
TwinCAT 3 – Programming in C/C++

- Motivation: Easy reuse of existing C/C++ code

- Cooperation of C/C++, MATLAB/Simulink and PLC code
- Standardized (C: ISO/IEC 9899 TC3, C++: IEC 14882)

- Integrated Wizards for easy start

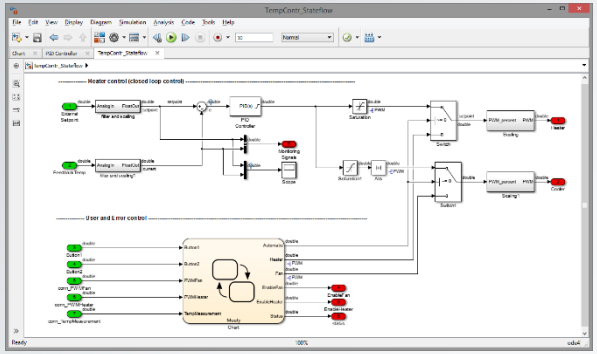
- Beckhoff Software Development Kit (SDK) delivers functional range of (analog to PLC-Libraries)
  - ADS
  - Motion
  - File IO
  - ….

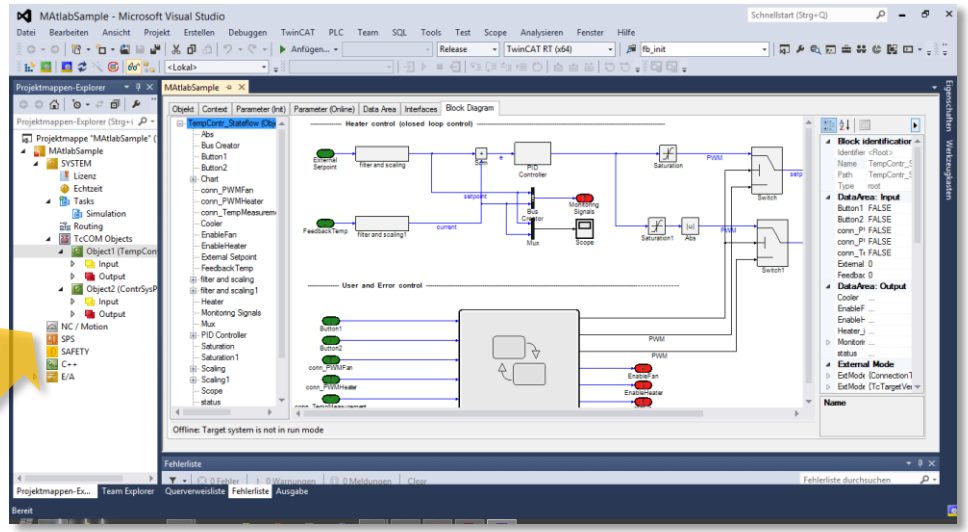


TwinCAT 3 – Using MATLAB/Simulink

- Reuse controllers/simulations made in MATLAB/Simulink and toolboxes
- Includes online block diagram, easy parameter change, debugging

Simulink-Model
Build with MATLAB/Simulink





Load into TwinCAT 3 XAE

TcCOM-Modul
Automatically build with
MATLAB&Simulink coder and
Microsoft C compiler
TMC file - XML description

MathWorks
Partner

MATLAB®/Simulink® integration

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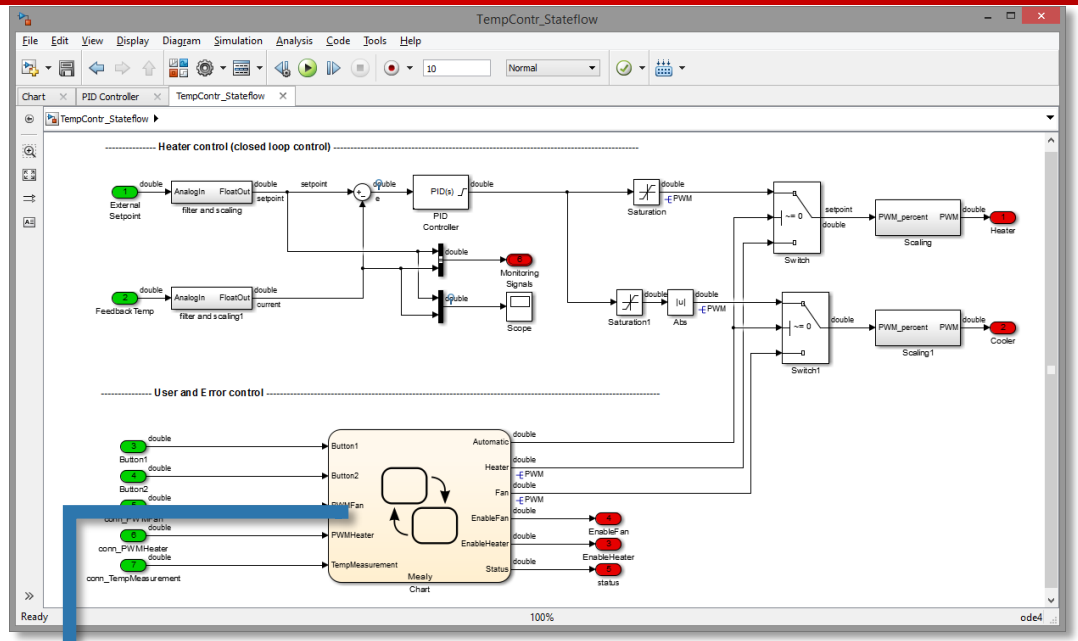

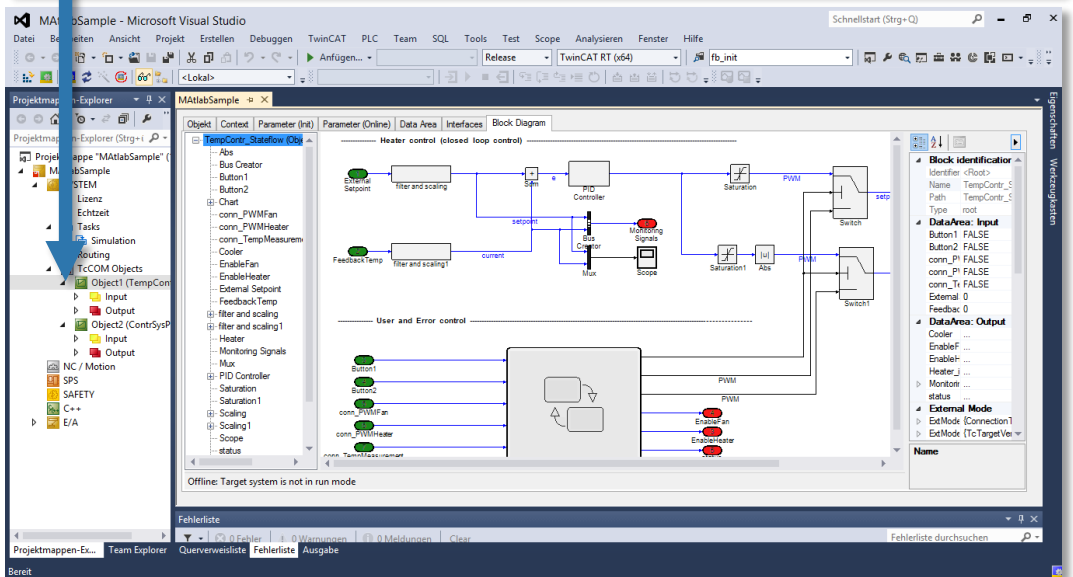

Success Story – also with TwinCAT 3/MATLAB

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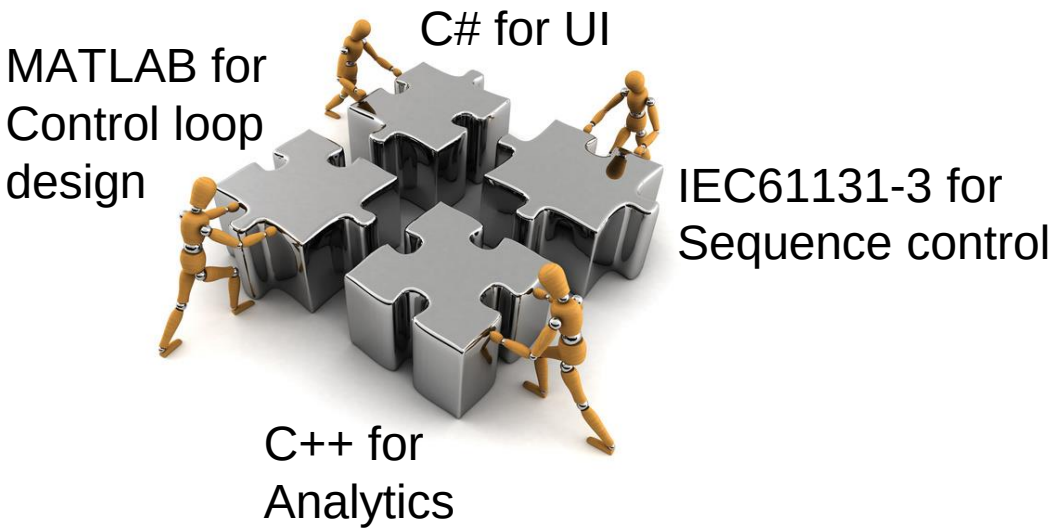
TwinCAT 3 supports teamwork by design

Modular concept allows to work in parallel

Source code management integrated in Visual Studio Shell provides team work mechanism like Team Foundation Server but also third party products like Subversion



Integration of source control management

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- **Well-known methods from IT**
  - version management of source code, bug tracking, project management
  - mostly integrated in Microsoft Visual Studio
- **Essential capabilities for**
  - large projects
  - collaboration of developer teams
  - lifecycle management

Integration of source control management

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- Visual Studio supports various source code management tools:
  - Microsoft Team Foundation Server
  - GIT
  - Subversion
  - Plastics SCM and others

→ TwinCAT supports all these tools

→ All TwinCAT configuration and programming data is ASCII/XML

→ Database storage

  → for configuration data (including motion/safety)

  → program code for IEC 61131-3/C++

  → Diagnosis data (TwinCAT Scope)

  → HMI data (TwinCAT HMI)

Integrated compare tool

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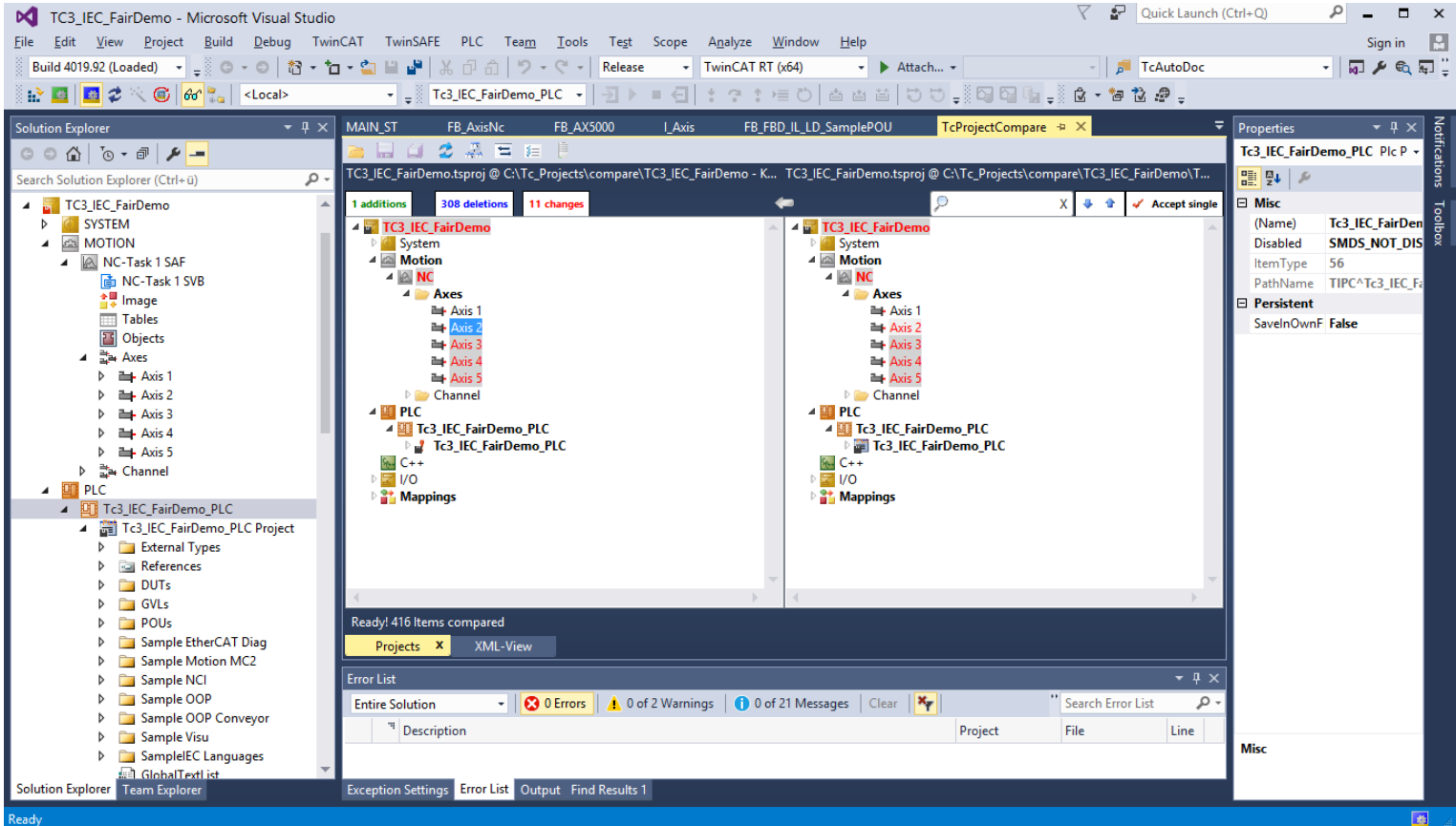
- Usage of encrypted sources is supported to enable data security management.
- also available as standalone version (but without encryption)



Automatic code generation with Automation Interface

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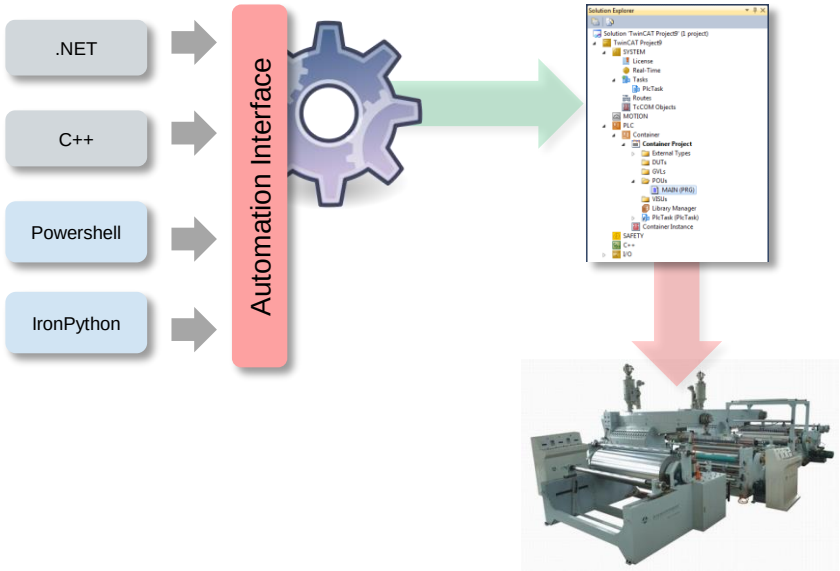
Automation Interface allows automatic generation of configurations and program code – saves time and costs in engineering

- Enables automated TwinCAT generation via COM
- Supports common programming languages:
  - .NET (C#, VB, …)
  - C++
- Usage of script languages possible:
  - Powershell
  - IronPython
- Supports remote configuration
- Well documented in our Information System
- Many samples available



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1. **TwinCAT 3**
   - **Powerful runtime**
2. TwinCAT Analytics
3. Summary

TwinCAT 3 | Best Performance

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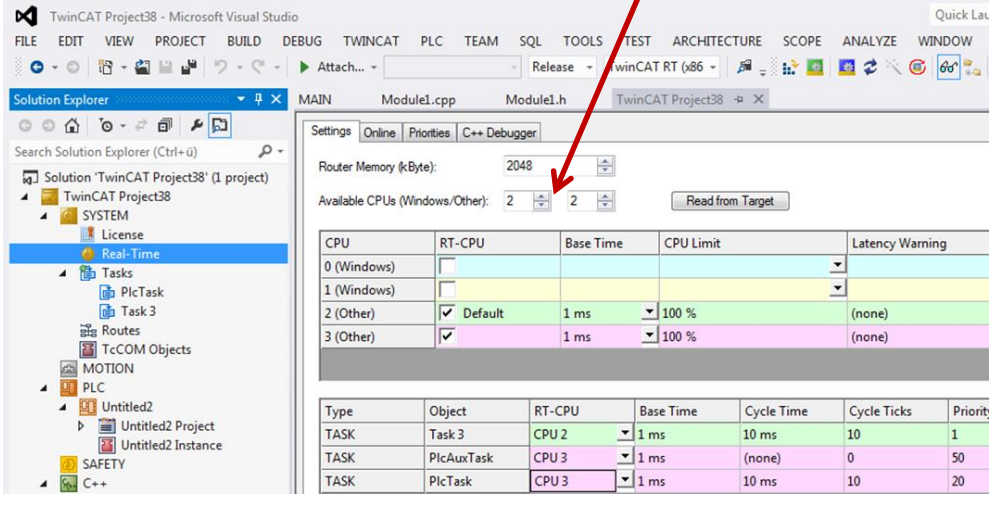
- Supports multi core architectures and 64bit OS – also on Many Core CPUs (like C6670)
- Supports TwinCAT core isolation
- Easy configuration and interaction between tasks on different cores
- With EtherCAT – eXtreme Fast Control

XFC
eXtreme Fast Control Technology

→ Best usage of processor performance for your application!

CPU Core isolation



Many Core Server C6670
- Up to 36 cores!

Agenda

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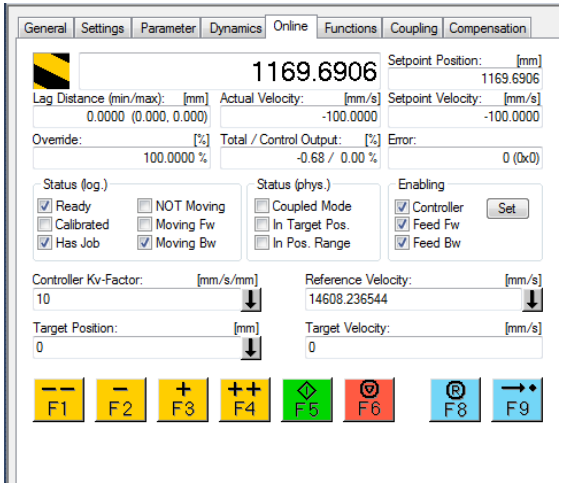
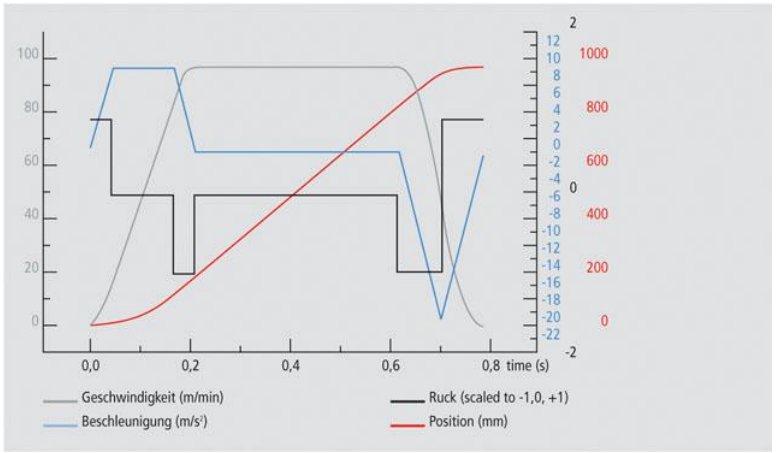
1. **TwinCAT 3**
   - **Open and flexible Motion solution**
2. TwinCAT Analytics
3. Summary

- Easy setup – supports scan of axes and motors
- Automatically setting all parameters
- Abstraction layers allow identical programming of all drives
  - Openess: Supports Beckhoff and Third party drives
  - Scalability: Small steppers up to servo drives
  - Standard: Support of PLCopen Motion FB‘s
  - Functionality: Single axis, PTP up to high complex CNC





Agenda

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1. **TwinCAT 3**
   - **Integrated Safety**
2. TwinCAT Analytics
3. Summary

TwinCAT 3 | Safety

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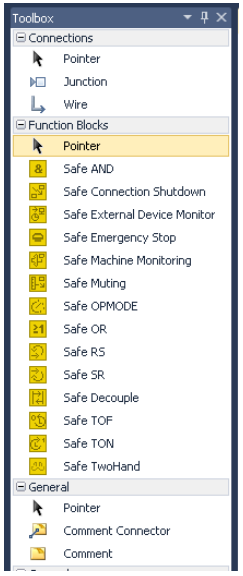
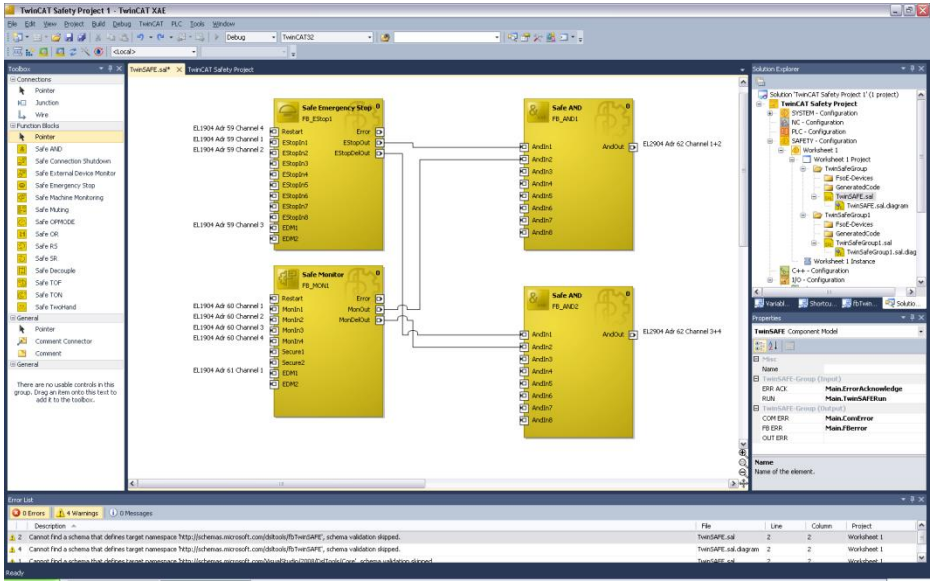
- Powerful graphical configuration and programming interface
- Comprehensive development environment to program and configure I/O hardware with one single tool – including online monitoring
- Safety up to SIL 3 (DIN EN 61508)
- Many available Function blocks – i.e. Emergency Stop
- TwinCAT Safety PLC – in Software supports also C as a new language





Agenda

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1. **TwinCAT 3**
   - **Diagnosis features**
2. TwinCAT Analytics
3. Summary

TwinCAT 3 | Analytics and Diagnostics

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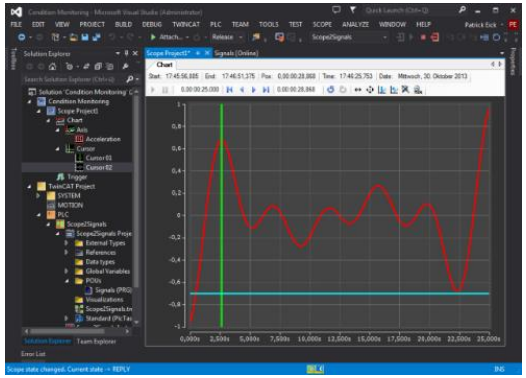
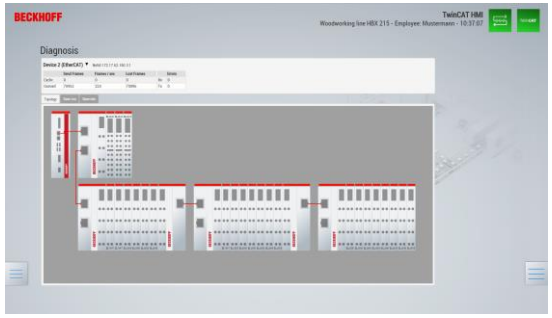
TwinCAT 3 includes easy, powerful tools

- TwinCAT Scope:
  - Integration in Visual Studio
  - Drag & drop of PLC variables enables quick diagnostic



- NEW (end of 2016):
  - Beckhoff Diagnostic Suite
  - Based on TwinCAT HMI
  - Web based (no TwinCAT Installation needed)
  - Included
    - IPC Diagnostic
    - EtherCAT Diagnostic (Topology View)
    - And more…



TwinCAT 3 Scope: integrated realtime Scope

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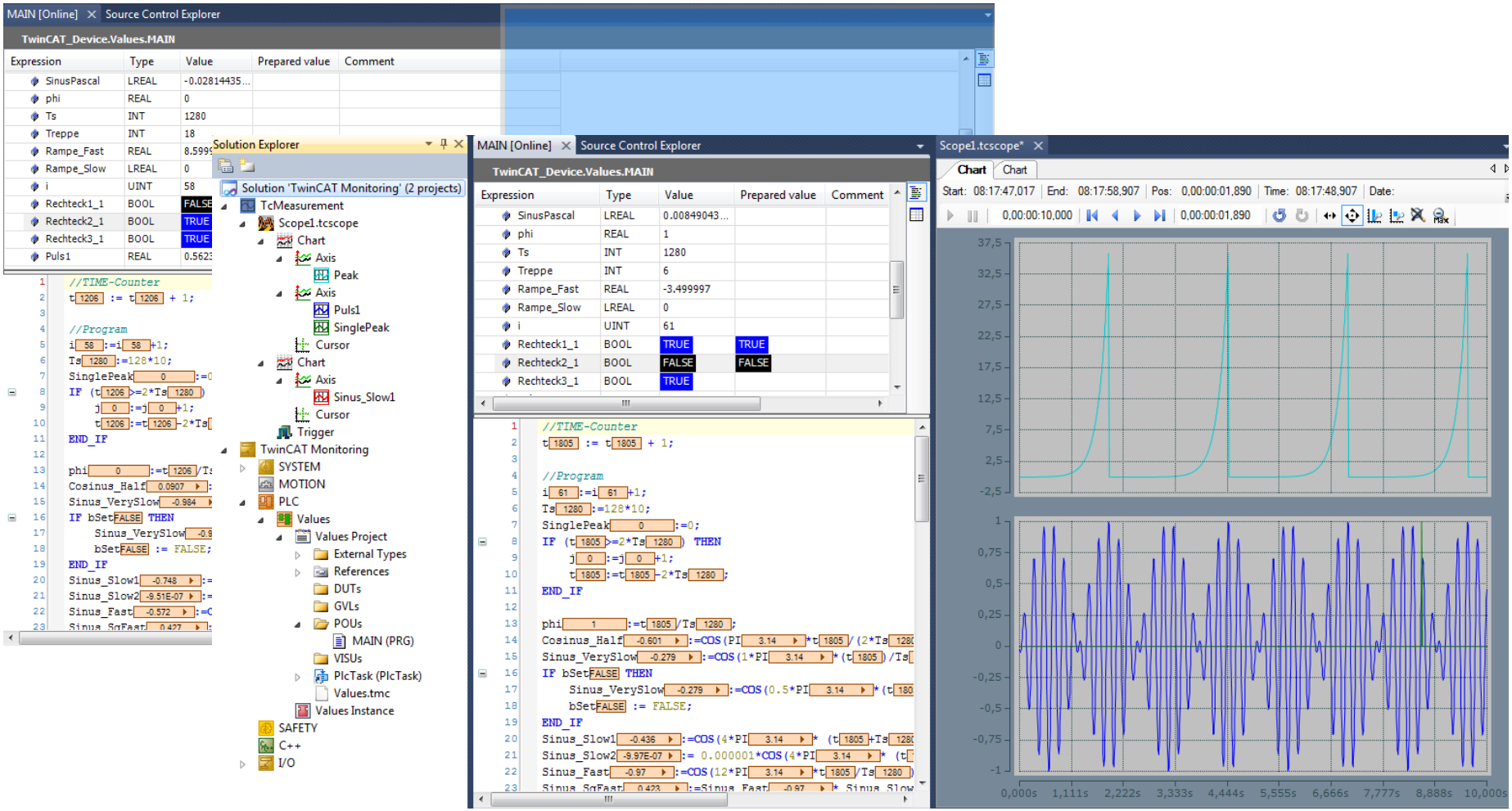
Easy Engineering: Configuration, setup and debugging in ONE environment!



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1. **TwinCAT 3**
   - **Open Connectivity with different protocols**
2. TwinCAT Analytics
3. Summary

ADS (Automation Device Specification)

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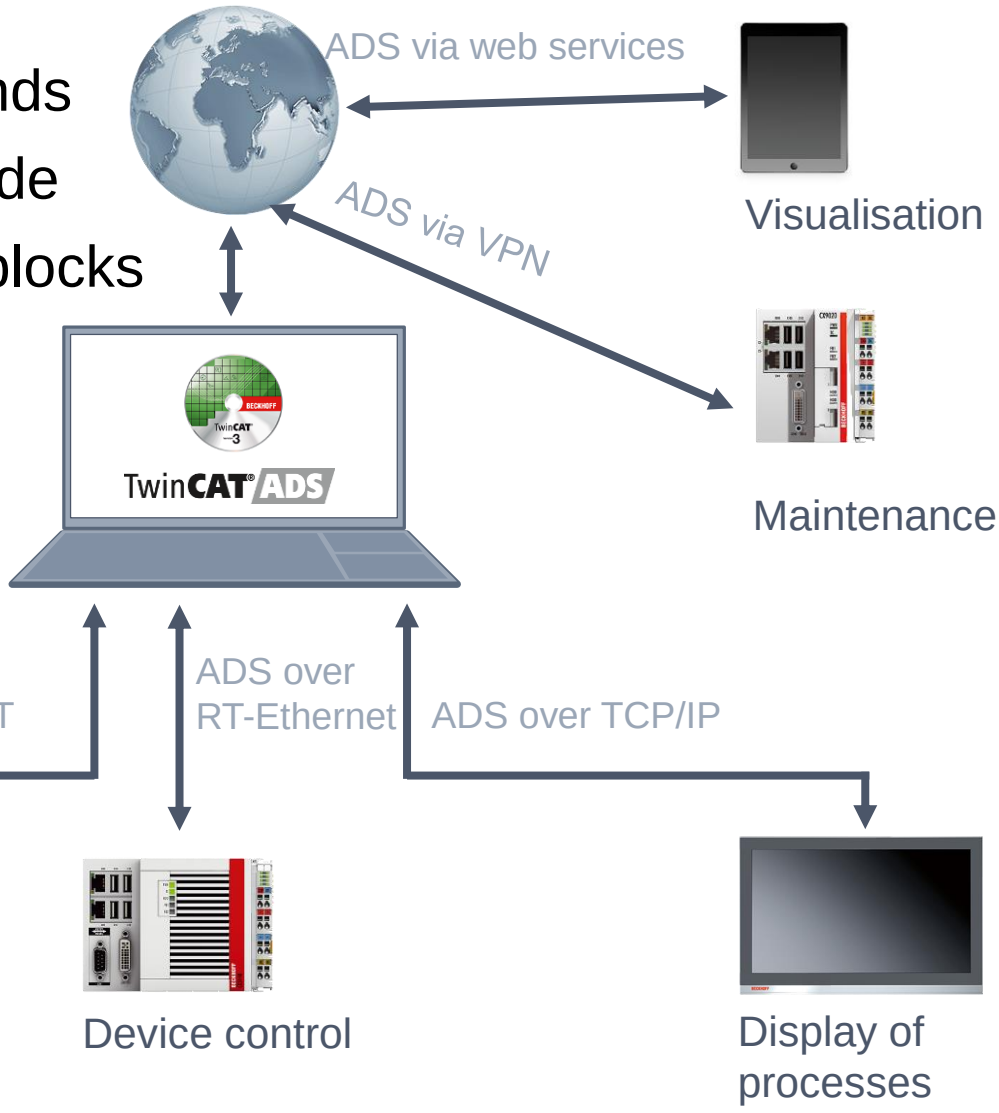
- vertical, horizontal
- data exchange and/or commands
- open protocol with example code
- access from PLC via function blocks
- routable via: local/network
- cyclical/event-driven

Components free of charge
OCX/DLL/.NET/Script/Webservice



Agenda

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1. **TwinCAT 3**
   - **Costs**
2. TwinCAT Analytics
3. Summary

TwinCAT3 Pricelist

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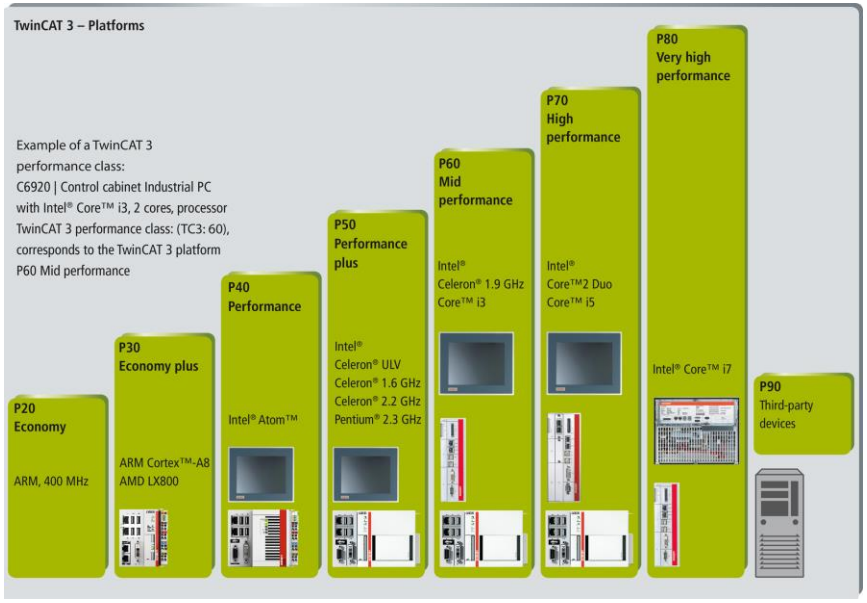
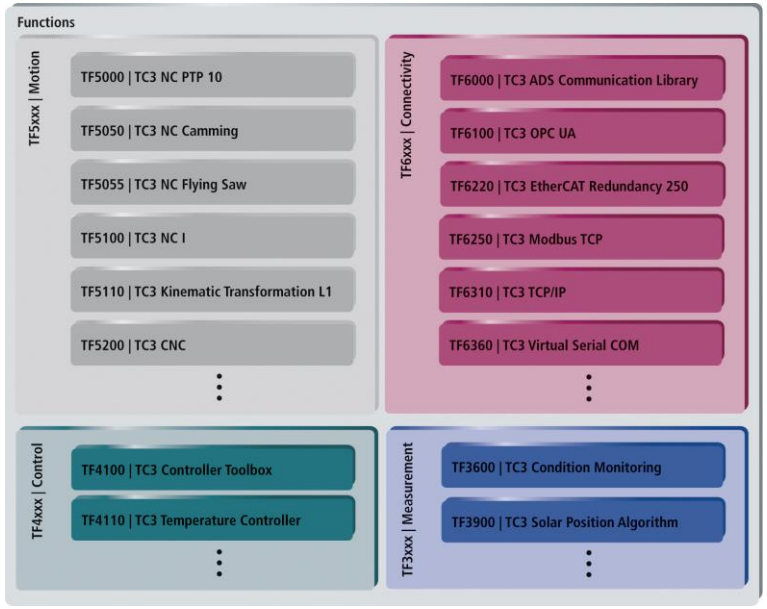
Simple & scalable licensing model

- License per function out of huge catalogue
- License fee dependant on performance of CPU
- Updates per version release free of charge
- No cost for engineering of base development tools
- No annual fees for programming tools or updates
- Basic support free of charge - hotline





Agenda

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1. TwinCAT 3
2. **TwinCAT Analytics**
3. Summary

Solution for Analytics

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- Where is the data?
  - Stored in a cloud
- How to get the data into the cloud?
  - TwinCAT IoT
- What to do with the data?
  - Easier remote service – find failures
  - Predictive Maintenance
  - Machine Optimization
  - Machine Learning

Analytics Infrastructure

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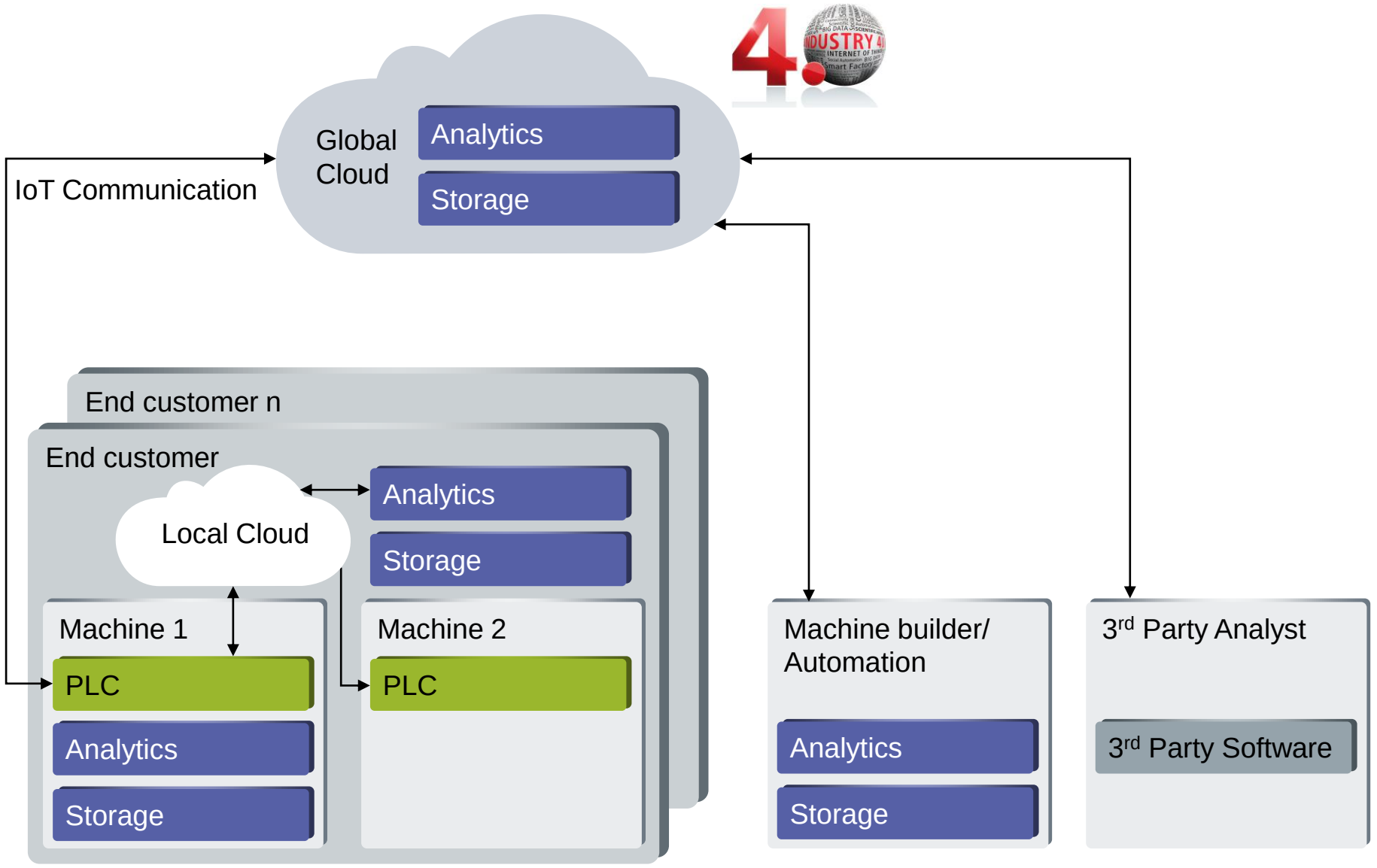

TwinCAT Analytics

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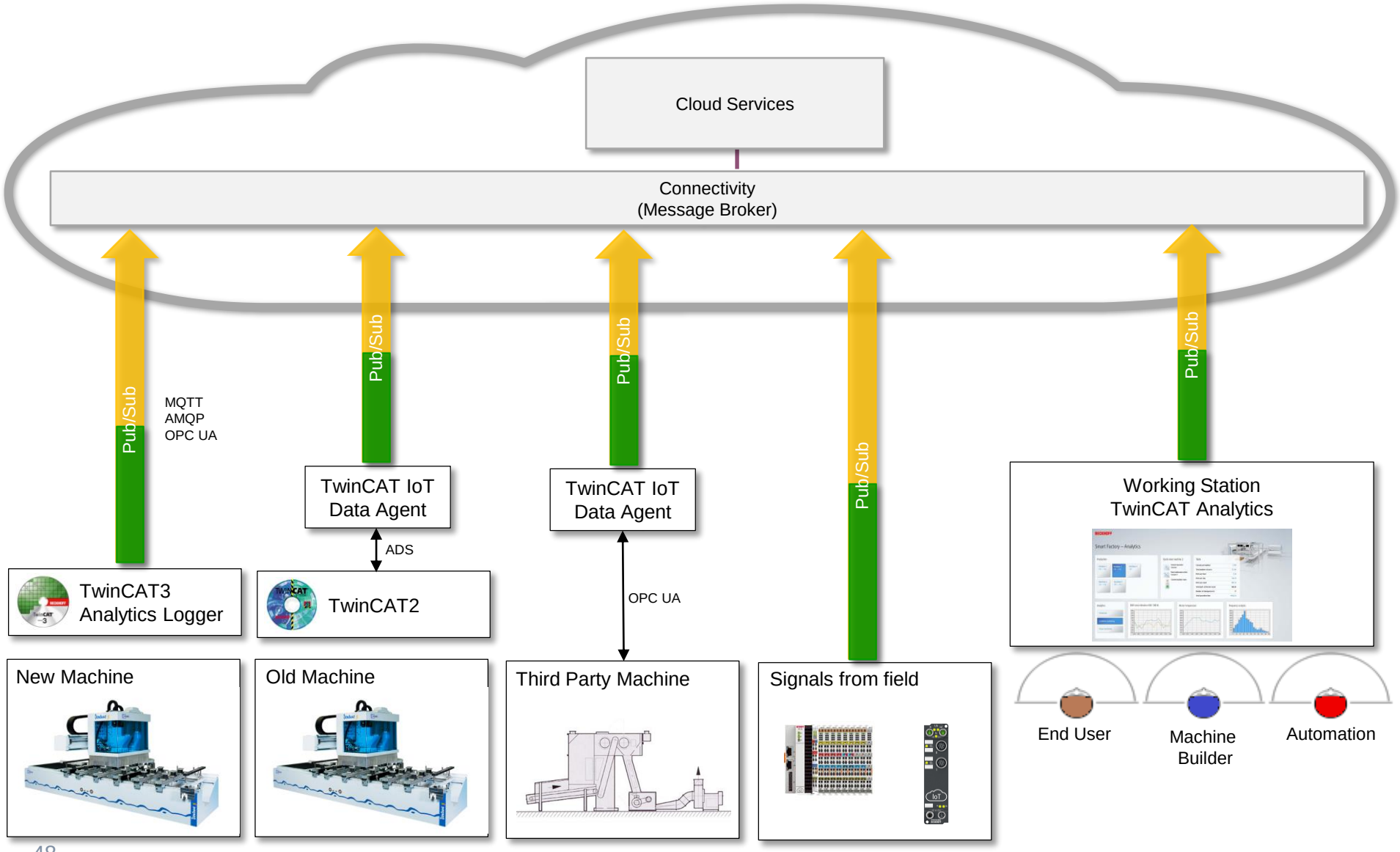
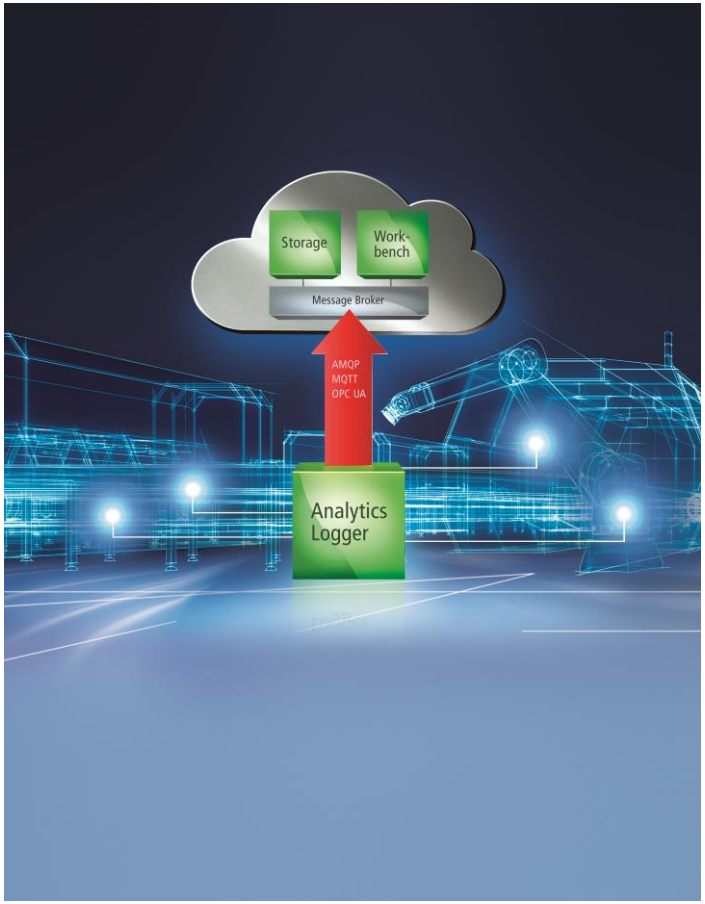


TwinCAT Analytics products

- **TE35xx Analytics Workbench**
  - Base package with: PLC runtime, Analytics configurator, Analytics library, Scope View Professional and IoT Communication
  - Extendable with Condition Monitoring, C++ and Matlab®/Simulink®
- **TF3500 Analytics Logger**
  - Record cyclic data from process image, PLC and NC etc.
- **TF3510 Analytics Library**
  - PLC library with basic algorithm like time analysis, edge event counter etc.
- **TF3520 Analytics Cloud Storage Provider**
  - IoT Storage Client gateway with data description for TwinCAT Analytics data



Agenda

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1. TwinCAT 3
2. TwinCAT Analytics
3. **Summary**

Working with Beckhoff - Business Value for Customers

- **Leading edge automation technology**
  - Innovative OEM solutions ahead of competition
- **Ready-to-use Industry 4.0 solutions**
  - Easy integration of Industry 4.0 in OEM solutions
- **Support of open standards**
  - Wide choice, easy integration & connectivity, low costs
- **Efficient & fast engineering**
  - Short & cost-effective development – similar to standard IT
- **Protection of OEM know-how**
  - User access management & encryption for OEM application software

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Thank you!