TwinCAT 3

Leading Edge Automation Technology

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TwinCAT Product Management
Agenda

1. TwinCAT 3
   - Modular Software for modular machines
2. TwinCAT Analytics
3. Summary
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   - Modular Software for modular machines
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3. Summary
TwinCAT 3 – Modular Software Architecture
Modular Runtime
Configuration instead of programming

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

- Application independent from hardware
- Free HW choice - exact fit to application requirement
- From low cost up to ultra high performance (*Many Core*)
1. TwinCAT 3
   - Supporting Standards
2. TwinCAT Analytics
3. Summary
Support of Open Standards

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
1. TwinCAT 3
   - Effective Engineering
2. TwinCAT Analytics
3. Summary
Workbench Integration

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!
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
TwinCAT 3 – Different ways of doing realtime programming

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
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

**Benefits of OOP**
- enhanced transparency
- structured code
- enhanced reusability
- reduced engineering times
- reduced engineering costs
- enhanced readability
- enhanced expandability

**In operation**
- easy maintenance
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

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

Load into TwinCAT 3 XAE
MATLAB®/Simulink® integration
Success Story – also with TwinCAT 3/MATLAB

MPI
CableRobot Simulator
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

MATLAB for Control loop design

C# for UI

C++ for Analytics

IEC61131-3 for Sequence control
Integration of source control management

- **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

- 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)
- 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

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
1. TwinCAT 3
   - Powerful runtime
2. TwinCAT Analytics
3. Summary
TwinCAT 3 | Best Performance

- 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

→ Best usage of processor performance for your application!
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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
  - Openness: 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
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1. TwinCAT 3
   - Integrated Safety
2. TwinCAT Analytics
3. Summary
- 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
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1. TwinCAT 3
   - Diagnosis features
2. TwinCAT Analytics
3. Summary
TwinCAT 3 | Analytics and Diagnostics

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

Easy Engineering: Configuration, setup and debugging in ONE environment!
1. TwinCAT 3
   - Open Connectivity with different protocols
2. TwinCAT Analytics
3. Summary
**ADS (Automation Device Specification)**

- 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

- Fieldbus access
- Device control
- Display of processes

Methods:
- ADS over EtherCAT
- ADS over RT-Ethernet
- ADS over TCP/IP

Visualisation
Maintenance

ADS via web services
ADS via VPN
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1. TwinCAT 3
   - Costs
2. TwinCAT Analytics
3. Summary
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
1. TwinCAT 3
2. TwinCAT Analytics
3. Summary
Solution for Analytics

- 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
TwinCAT Analytics

Connectivity
(Message Broker)

Cloud Services

Working Station
TwinCAT Analytics

End User
Machine Builder
Automation

New Machine
Old Machine
Third Party Machine
Signals from field

TwinCAT IoT
Data Agent

TwinCAT IoT
Data Agent

TwinCAT Analytics Logger

TwinCAT3

TwinCAT2

MQTT
AMQP
OPC UA

Pub/Sub

Pub/Sub

Pub/Sub

Pub/Sub
## 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
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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
Thank you!