eXtended Automation Engineering (XAE):
Visual Studio® 2010 – enhanced for automation

TwinCAT 3 – convergence of technologies

Beckhoff has adapted useful mainstream technologies from the IT industry for automation with the new software generation, TwinCAT 3. As a result, Microsoft Visual Studio® 2010, the world-famous IT tool, can now also be optionally used for automation and application programming. All main programming languages such as C/C++, Matlab®/ Simulink® or the object-oriented IEC 61131-3 extensions are integrated in a single development environment.

Real-time

Non-real-time

System Manager

LD editor

FBD editor

SFC editor

IL editor

ST editor

CFC editor

Visual C/C++ editor
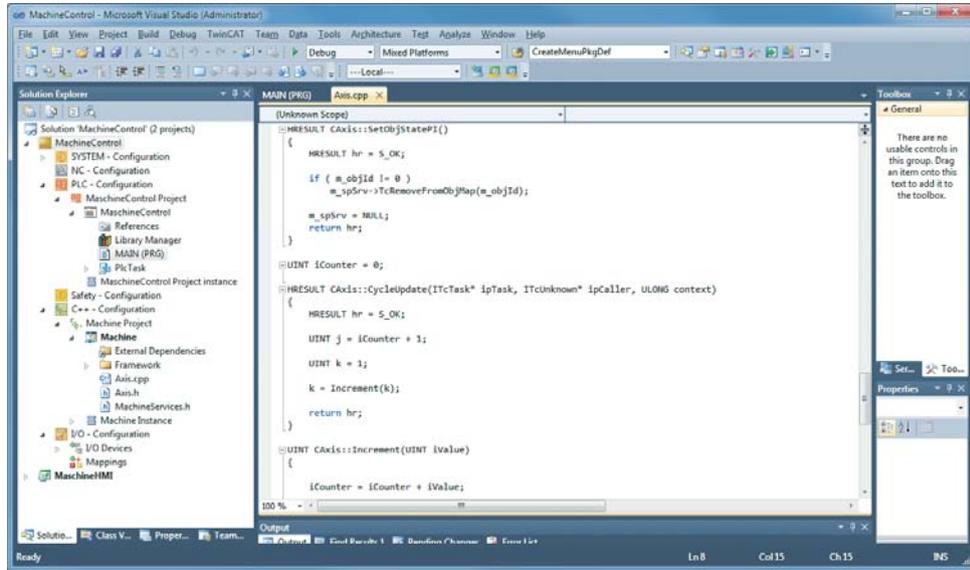
C#

.NET

Visual Basic

C++

Silverlight

Visual Studio® integration: Automation devices and application programming in one environment

TwinCAT 3 is the result of the consistent technological development of the familiar TwinCAT 2 automation software, which has been tried and tested in numerous applications around the world. In addition to the object-oriented IEC 61131-3 extensions, the languages C and C++ of the IT world are now also available to TwinCAT users. The integration of Matlab®/Simulink® also opens the way for scientific applications. The modules written in different languages run in a common eXtended Automation Runtime (XAR). This provides an answer to harsh real-time conditions with the use of multi-core technology and the support of 64-bit operating systems. The implementation of TwinCAT 3 modules and the configuration of the overall system take place in the eXtended Automation Engineering environment (XAE), which is based on Microsoft Visual Studio.

TwinCAT 3 modules integrate themselves as "Visual Studio Extensions" into the Microsoft Visual Studio 2010 environment.

eXtended Automation Engineering (XAE)

The engineering environment used by TwinCAT 3 is the Microsoft Visual Studio 2010 development environment, which is commonly used in IT software development. The two modes, "TwinCAT 3 Standard" and "TwinCAT 3 Integrated," use the "Visual Studio Shell" version, which is accessible via the Microsoft program "Visual Studio Industry Partner" (VSIP). The earlier Visual Studio 2008 version had already provided a business model in VSIP that makes it possible to use and to easily customize the Visual Studio development environment. The free basic version of "Visual Studio Shell" additionally offers all of the functions required by a modern development environment in order to support modular software development: Besides the interfaces for inserting proprietary editors into the project engineering tree or into the menus, all other services can be used, from the compiler to the help system. With expandability via plug-ins – the so-called "VS-Extensions" – the framework can grow and be adapted and updated rapidly and modularly with proprietary technological know-how.

TwinCAT 3 in "Standard" mode

There are two possibilities to install TwinCAT 3 on a target system: If no Visual Studio 2010 version currently exists on the target system, then a free basic version of the VS Shell with the TwinCAT extensions is installed with TwinCAT 3. This use of the shell is called the "Isolated Mode": several hundred companies use the VSIP program and can load their extensions into their own instance of the VS Shell. As a result, many "Isolated Mode"-based applications can be operated in parallel without disruptions. The TwinCAT mode "TwinCAT 3 Standard" is intended for all users who only wish to configure and to use IEC 61131 exclusively as a programming language set. The System Manager dialogues familiar from the TwinCAT Version 2 environment have been adopted, so that the user
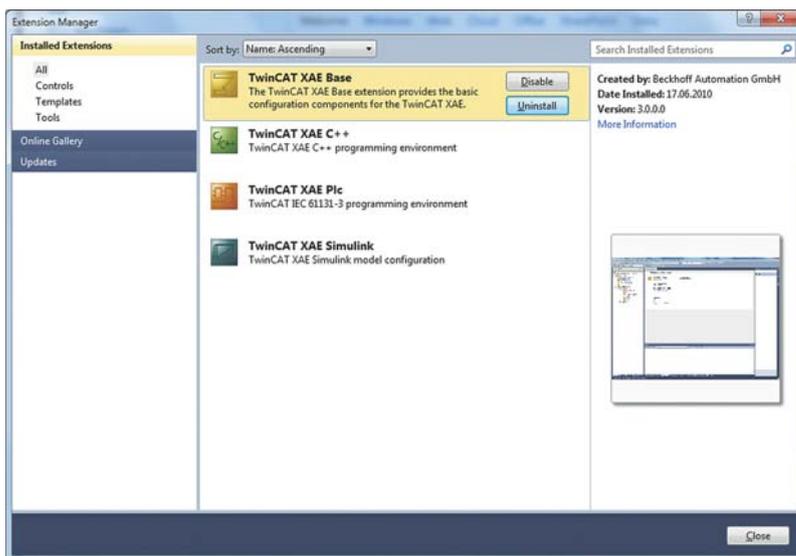
immediately finds themself on familiar ground. The use of TwinCAT C or Matlab®-Simulink® modules at runtime is possible, but the appropriate VS environment for changing or debugging C/C++ code is not available.

### "TwinCAT 3 Integrated" offers access to the C/C++ world

If one of the Visual Studio 2010 versions "Professional," "Premium" or "Ultimate" is available on the target system, then there are two options: Here too, TwinCAT 3 can be installed in parallel in a "VS Shell in Isolated Mode." It makes more sense, however, to use the operating mode "TwinCAT Integrated," which integrates itself into the VS2010 existing on the computer. The C/C++ programming language is thus additionally available for real-time tasks.

The modular Visual Studio environment can also be extended by components from the "Visual Studio Gallery": In addition, information on the VS extensions available in the Internet marketplace can be displayed in the "Extension Manager" menu. Products can be bought, graded and commented on in the Microsoft marketplace. Currently more than 1286 extensions from various suppliers are available for direct download and for integration in the VS Shell for the Visual Studio 2010 platform alone. Some of the extensions on the marketplace are free. The variety of the VS

one another: Using TwinCAT 3, PLC programmers can use additional object-oriented functions that the PLC world had previously been denied: TwinCAT 3 already offers the features of the new IEC 61131-3 3rd Edition. With respect to the object-oriented programming structures, the advantages of the extension and modernization of the standard can already be used in all languages within IEC 61131. The possibilities include single inheritance as well as the possibility to use interfaces, methods and attributes.

The implementation in C/C++ code is beneficial above all to users from the image processing, measuring technology and robotics industries: Axis transformations can be created more efficiently; a C-code basis is frequently already available and can now be easily integrated into the powerful TwinCAT 3 substructure. Talented young programmers do not learn PLC sequential function charts at university, but modern high-level languages instead. However, C/C++ programmers will also have to get used to a different procedure. Whereas most developers have so far mostly created event-controlled applications, the C-code is now executed cyclically in the real-time context.

If actions are to be started in the C-code that require a longer processing time than the cycle time allows, then these tasks must be decoupled.
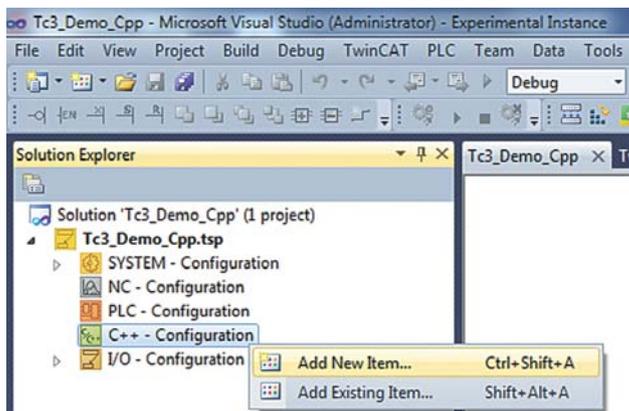
In addition to I/O configuration and PLC programming, C/C++ code can also be created in the TwinCAT 3 project. Wizards for the creation of basic projects, classes and I/O variables make efficient engineering possible.

extensions is virtually unlimited: From .NET or Silverlight components for the creation of operating interfaces, or tools for generating setups or for the modeling of software packages, to team development tools, such as SVN SubVersion as an alternative to the existing Team Foundation Server (TFS). All marketplace components promise to facilitate engineering.

Enhanced for use in automation technology

In addition to the C/C++ languages, Beckhoff has also integrated the IEC 61131 programming options and the TwinCAT System Manager – the configuration tool for system, modules, I/O and motion – into this modular VS development environment. This means that two tools with mutual export/import steps are no longer necessary for the exchange of configurations during engineering: Integration into a uniform environment simplifies handling, dispenses with administrative detours, accomplishes tasks automatically in the background – thereby eliminating possible sources of error – and in this way makes more efficient engineering possible.

An exciting observation is how the implementation possibilities in the two worlds of the conventional PLC and C-coding are growing toward

Beckhoff provides a "Software Development Kit" (SDK) for this, in order to start actions from the deterministic real-time process and to monitor the processing status: the reading/writing of files, the starting of threads, the allocation of memory and communication with databases takes place via functions from the SDK and corresponds to the mechanism of the use of PLC libraries familiar to the PLC programmer.

The C compiler contained in Microsoft Visual® Studio 2010 is used for the generation of C-code. After the compilation the object code is loaded into the real-time runtime system in the form of dynamically loadable libraries (DLL). The user is thus able to extend the TwinCAT system with program modules.

Diagnostic options, such as the monitoring and changing of process variables during a running PLC cycle, are matters of course for PLC programmers. A C developer doesn't get very far with the available on-board mechanism and must initially stop the execution of the code with a breakpoint in order to modify the status of the symbols in the watch window. Here, too, Beckhoff has extended the Visual Studio® options and created ideal diagnostic options for the use of C/C++ in automation technology: A custom debug transport channel was created with the aid of the
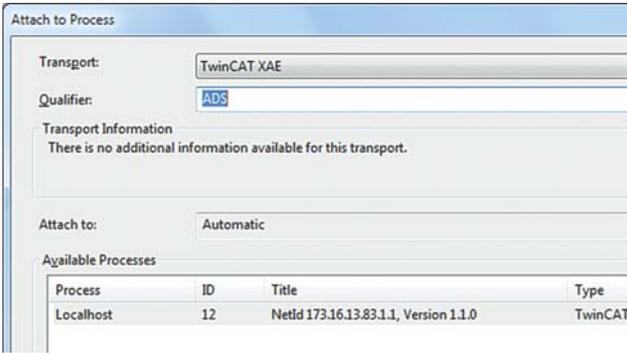
TwinCAT 3 offers significantly improved online and debugging options for C/C++ applications: The custom transport channel allows the selection of local and remote TwinCAT C/C++ modules.
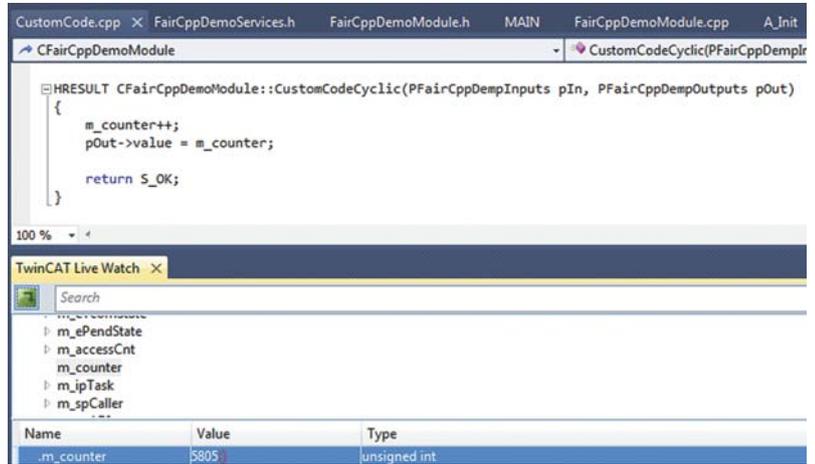
The routine "CyclicUpdate" is cyclically processed. The internal variables are available for monitoring in the TwinCAT online watch window even without having to set a breakpoint.

"Custom Debugger Interface." The online data are subsequently available in a "TwinCAT watch" window for monitoring and changing, without having to stop the machine sequence with a breakpoint. This diagnosis of the real-time application is available both locally and via remote access. Visual Studio® offers further languages for designers: Silverlight-Designer or .NET-based languages, such as C#, can be used for the programming of non-real-time parts of the application, e.g. the user interface.

In the "Visual Studio® Shell," Microsoft supplies a platform with the necessary interfaces for extensions. Its combination with the Beckhoff extensions for automation technology results in the powerful, modular platform called "eXtended Automation Engineering" (XAE): All components, from the I/O configuration, the PLC and/or C-code, up to the GUI or database linking, can easily be managed in the same project for team use as well. Beckhoff has once again remained true to its philosophy:
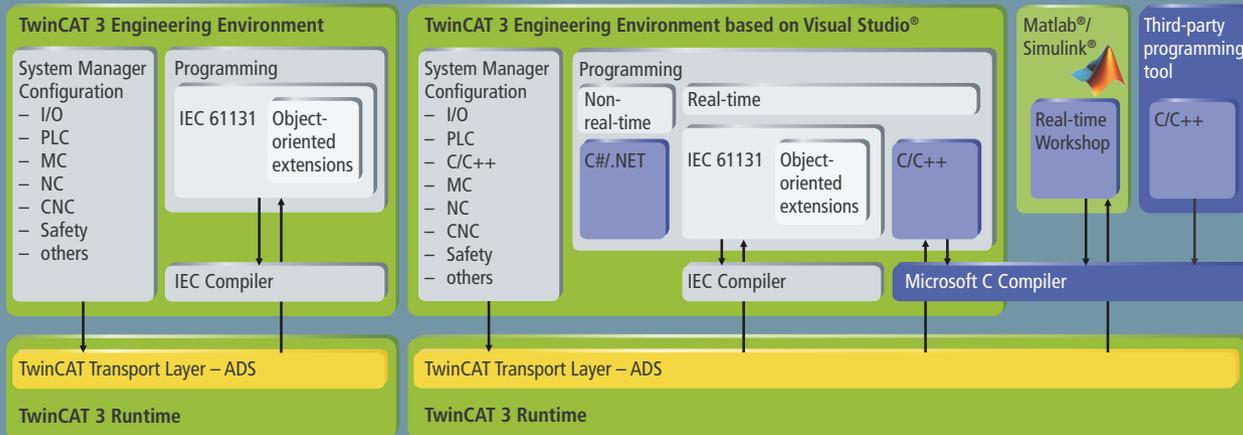
beneficial and commonly used solutions from the IT world are accepted and used for automation technology.

www.beckhoff.com/TwinCAT3

i Product announcement estimated market release 2nd quarter 2011

Visual Studio® integration can be accomplished in two different ways. TwinCAT Standard only uses the basic framework of Visual Studio® with all its benefits in terms of handling, connection to source control software, etc., while TwinCAT Integrated integrates itself into Visual Studio®. In this version the C/C++, C#, VB.NET programming languages and link to Matlab®/Simulink® are available.