Data mining and analysis – a prerequisite for Industrie 4.0 concepts

“Now all data can be saved and evaluated for advanced analysis – without exception”

TwinCAT IoT and TwinCAT Analytics are the first “real” Industrie 4.0 products, said Hans Beckhoff at a company presentation during the SPS IPC Drives 2015 trade fair. Michael Corban, editor-in-chief at Elektro Automation, talked to Dr. Josef Papenfort, Pascal Dresselhaus and Sven Goldstein at Beckhoff global headquarters about this. The bottom line: Machine and plant engineers are now able to save all the data available from control systems – either locally or in a cloud – providing the ability to obtain more detailed knowledge about the machines in operation. Predictive maintenance and machine learning are only two of the key technologies that demonstrate the advantages for automation engineers and plant operators.
Elektro Automation: Hans Beckhoff said that “All Beckhoff control systems should be able to talk with the cloud and it should be possible to send ‘all’ the data if required,” at last year’s SPS IPC Drives trade fair and referred to TwinCAT IoT (Internet of Things) and TwinCAT Analytics as the first “real” Industrie 4.0 products. What is the motivation behind these developments and what benefits can the user expect?

Dr. Josef Papenfort: The idea of being able to seamlessly record and save ‘all’ process data in a cyclically synchronized manner is very tempting in principle. Once the data is available, this would make online and offline analysis possible to an extent never known before – especially because now all sensor data really can be recorded. One goal in particular is using predictive maintenance to increase system availability. However, the data could also be used to optimize machine performance and processes. Many customers are already running condition monitoring as an application on the machine control system. Of course, this can be used to analyze machine data locally, as well. If the data is saved to the cloud – or better yet in a network that many people have access to – other specialists can analyze the data and form valuable conclusions. This is where the machine manufacturers, and their automation and system engineers, are in demand as specialists. New business models could be implemented, allowing manufacturers – who know their machines best – to offer remote services such as predictive maintenance or machine optimization.

Sven Goldstein: I would also like to mention that we enable the installation and configuration of MQTT and AMQP devices in a local machine network as well – use of a public cloud is not required. This decision is often dependent on which IT infrastructure the customer has available and their IT expertise. Anyone who doesn’t want to invest intensive time and effort in this will find a public cloud system solution quite attractive.

Elektro Automation: When ‘all’ the data is saved, you quickly end up with enormous amounts of data. Does it make sense to send only a certain selection to the cloud in order to keep the data volumes manageable?

Pascal Dresselhaus: That always depends on each individual application, and when particularly large data volumes are involved, it can make sense. On the other hand, the ability to explicitly access the complete data can be quite appealing. When, for example, a machine malfunctions in a way that it never has before, the analyst can go back to the complete set of data to find out exactly what happened. This makes it possible to avoid the frustrating situation that we
so often encounter today of having to wait for an error to occur again. Regardless, we are also thinking about data compression and ring buffers. However, it is our goal to lay the foundation for the future and for the ability to handle more complex analyses now, and that means it makes sense to be able to collect and analyze all the data. To do so for a longer period of time enables reliable analysis of the wear and tear on machine parts, for example.

Elektro Automation: Let’s suppose that all the data is saved. This poses the next exciting question – how can one best analyze it?

Pascal Dresselhaus: An important prerequisite for optimum analysis is the knowledge of the mechanics of a machine, and that’s exactly what mechanical engineers know. Meaningful analyses, for vibrations in particular, require detailed knowledge of the mechanical structure. That is why Beckhoff introduced the TwinCAT Analytics Configurator, an easy-to-use tool which can be used, first and foremost, to view the data. The user can select certain time periods and use this tool directly to perform basic analyses (such as frequencies and runtimes). Then the values can be viewed in the TwinCAT 3 Scope View tool, simply by using drag and drop to “move” them from the Configurator to Scope View. Relevant results – such as the occurrence of a maximum value – are then marked directly in Scope View. That makes it a great deal easier to search through the proverbial “haystack” and find exactly the data that you are interested in. In this way, the operator is able to analyze and identify the results of a loss in pressure, for example, which has an effect on the machine cycle.

Elektro Automation: With PC Control, it was already possible to perform analyses before; now what’s new is the Industrie 4.0 idea...

Pascal Dresselhaus: ...which enables me to perform the analysis separately from the machine. The analyses can be done directly at the machine, but just as well at your desk in the office – and not only for just one machine, but for many. IoT communication protocols make this high degree of flexibility possible because the data can be stored in a cloud, regardless of whether it’s a private or a public one.

Dr. Josef Papenfort: The main benefit for the users – often the machine or system manufacturer – is that data availability enables better resolution of problems occurring in the field, as far as their analysis is concerned. This sheds a whole new light on error analysis and the optimization of a machine in particular. It also addresses the following question: under which concrete conditions can a product be manufactured at peak efficiency and which conditions create more of a hindrance. In this way, it will be possible to find new and exciting answers to questions that involve maintenance and tool-change times.

Sven Goldstein: Then it is also possible to compare several different machines in the field – for example, compare an entire series of different machines in use by different customers. This uncovers enormous potential for the machine builder because it is possible to obtain a wider range of results that can lead to process improvements in all kinds of applications.

Elektro Automation: This lays the foundation for optimization processes in Industrie 4.0 scenarios. Are there already research projects in progress on this subject?

Dr. Josef Papenfort: Yes. Through our membership in the “it’s OWL” (intelligent technical systems OstWestfalenLippe) Leading-Edge Cluster, Beckhoff is the project leader for two projects. One project is entitled “ScAut” (Scientific Automation) with the goal of transferring engineering expertise from various disciplines into automation technology. The focus here is on collecting data that relates to intelligent measurement technology and optimization algorithms in particular. Only when automation technology integrates such intelligent processes and technologies can intelligent production systems be

“The potential for advanced data analysis goes right up to the establishment of new business models, such as for predictive maintenance.”

Dr. Josef Papenfort, TwinCAT Product Manager, Beckhoff
operated productively, reliably and energy-efficiently in the sense of sustainable production.

Elektro Automation: And the second project?

Dr. Josef Papenfort: The second project is called “efa” – eXtreme Fast Automation. The main goal of this project is to provide highly powerful PC-based control technology that automates the most complex production systems. This includes, for example, the distribution of control tasks to several different computing cores, as in our many-core computers. This also makes development tools and a drafting methodology available so third parties can integrate this technology into their own solutions. High computing power is one of the basic prerequisites – this is the only way in which all complex tasks, such as condition monitoring and image processing, can be realized in the first place.

Elektro Automation: Let’s take another look at the analysis options. You described the interaction between the TwinCAT Analytics Configurator and TwinCAT 3 Scope View. For the purposes of analysis, is it also possible to integrate simulation tools that product developers can use to take better advantage of these findings?

Dr. Josef Papenfort: The TwinCAT system we offer already provides an excellent engineering environment that automation and controls engineers are familiar with. This same environment is also used for analysis tasks, and can be used to operate a MATLAB®/Simulink® runtime. Algorithms from MATLAB®/Simulink® are available in different toolboxes and can, for example, be used for pattern recognition. Through seamless integration of PLC code, C++ code and MATLAB®/Simulink®, the engineer is completely free to choose a programming language or use existing solutions to create their own specific analysis system in this way. The goal is to provide an engineering environment that really does contain everything. This is the only way to provide end-to-end engineering within the realm of Industrie 4.0.

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“You can use a public cloud, but you don’t have to; we also make it possible to use private cloud systems by providing MQTT and AMQP functionalities in the local corporate network.”

Sven Goldstein, TwinCAT Product Management Connectivity & Embedded Systems, Beckhoff

The TwinCAT specialists Sven Goldstein, Dr. Josef Papenfort and Pascal Dresselhaus (from left to right) are intensively exploring the potential of Industrie 4.0 scenarios, in which added value can be generated from the much more extensive data storage options available today.

Further information: www.beckhoff.com/TwinCAT-Industrie40