SIEMENS
Ingenuity for life

The PLC is digitalization-ready

siemens.de/s7-1500

Authors

Andreas Czech
Marketing manager SIMATIC
Siemens AG, Nuremberg
Germany

Robert Winter
Product manager SIMATIC
Siemens AG, Nuremberg
Germany

Increased efficiency, higher quality, new business models: Digital processes and concepts have long been instrumental in ensuring a sustainable change to the value-added chain in industry. In addition to this higher-level development, a new task has also been allocated for the automation level: Increasingly, the PLC must assume the task of a data aggregator and data supplier, as well as support a flexible and transparent linking of process steps and machines. To minimize the complexity of machines with ever more modular designs, standardization is being increasingly applied as a basis for digitalization. OPC UA has established itself as a de facto standard for cross-manufacturer communication within the control level and for higher-level systems. As well as supporting OPC UA on a technical level, modern controllers also facilitate the implementation of suitable communication solutions.

Open Platform Communications – Unified Architecture (OPC UA) is the current OPC specification which allows an open, manufacturer and platform-independent, secure data exchange between industrial automation systems. This specification was adopted in its original version back in 2009, however, remained dormant for the majority of this time. As developments progressed in digitalization and the intelligent factory, OPC UA then emerged as a key component for users and developers in communication and data exchange for industrial automation.

OPC UA allows information to be read out, relayed and linked securely from the control, regardless of manufacturer

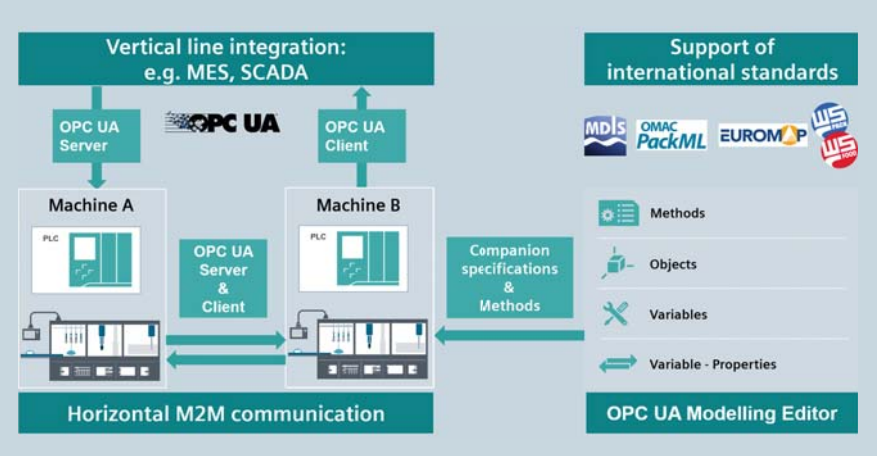
This development can be recognized easily by looking at online search queries: The number of searches for "OPC UA" has increased at least five-fold since the beginning of 2013, with OPC UA now considered in specialist circles as one of the forerunners of Industrie 4.0. Most providers of automation solutions now support OPC UA in their systems accordingly, albeit with varying characteristics, that is different OPC UA profiles.

OPC UA in the context of automation

In an industrial context, this standard allows a secured and reliable communication in modular, standardized production areas. OPC UA enables users to implement controlled and secure access to individual devices, as well as to complete machines. With OPC UA, machines can be incorporated in an existing automation and communications infrastructure, additional units such as feeding units can be integrated in machines, and communication can be established with SCADA and MES systems or to cloud solutions. A corresponding safety certificate and encryption of the communication ensures that only authorized participants with maximum security can access the data.

Communication via OPC UA thus functions independently of the respective platform or the automation system being employed, provided that the participants adhere to the current specifications of the OPC Foundation. In addition to these specifications, several so-called companion specifications have been established over the last few years, which are based on the OPC UA information model. These companion specifications help to describe the OPC UA communication for special industries or applications in a standardized form, for example for the packaging industry or robotics applications. Further specified interfaces or OPC UA models of individual companies also exist to support a standardization within the respective machine pool, as well as to allow flexible manufacturing concepts.

This openness entails that OPC UA on the automation level often differs.

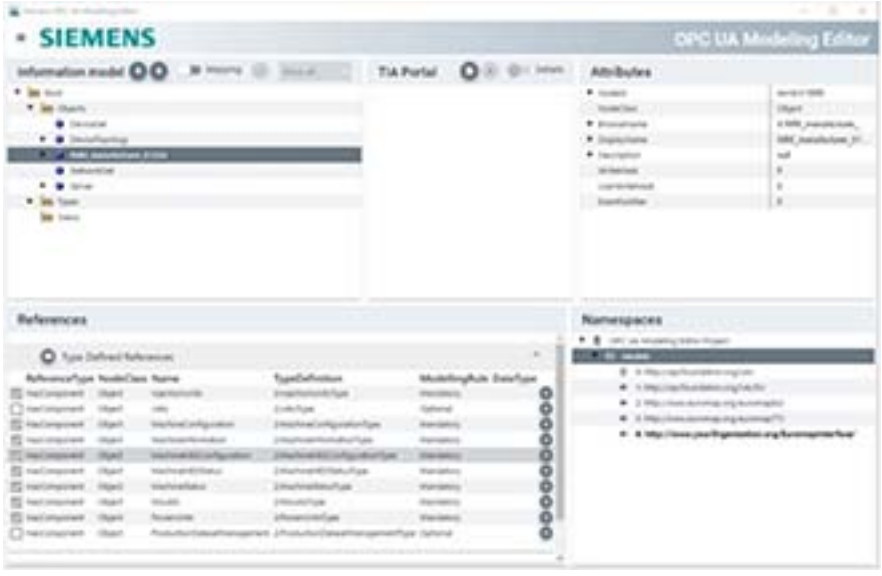


The client-server architecture of OPC UA enables communication to be implemented between controllers as well as between controllers and higher-level systems

Which in turn poses a challenge for the machine manufacturer: For automation and in particular the control system, alternative perspectives for automation and the machine must be supported.

In many cases, the OPC UA view of the individual devices is firmly embedded in the device and cannot be easily changed by the machine manufacturer. Typically, a companion specification is permanently implemented in the firmware.

Necessary changes are therefore only possible by adapting the firmware, requiring a certain amount of time and effort for the manufacturer of the device. Siemens adopted a far more flexible approach with the current SIMATIC S7-1500 controllers: This allows the OPC UA specification to be reloaded using an external tool which is provided free of charge. The Siemens OPC UA Modelling Editor (SiOME) enables the user to integrate and to instantiate respectively modified stipulations and data types of the specifications in the firmware. The machine manufacturers can now adapt their machine control systems flexibly to different access models in accordance with the diverse specifications of different manufacturers. This functionality is available within the SIMATIC S7-1500 controllers for all CPU variants and performance classes, allowing a corresponding OPC UA communication to be implemented for various applications and performance requirements. A machine manufacturer may therefore also develop and implement his own specifications as required.

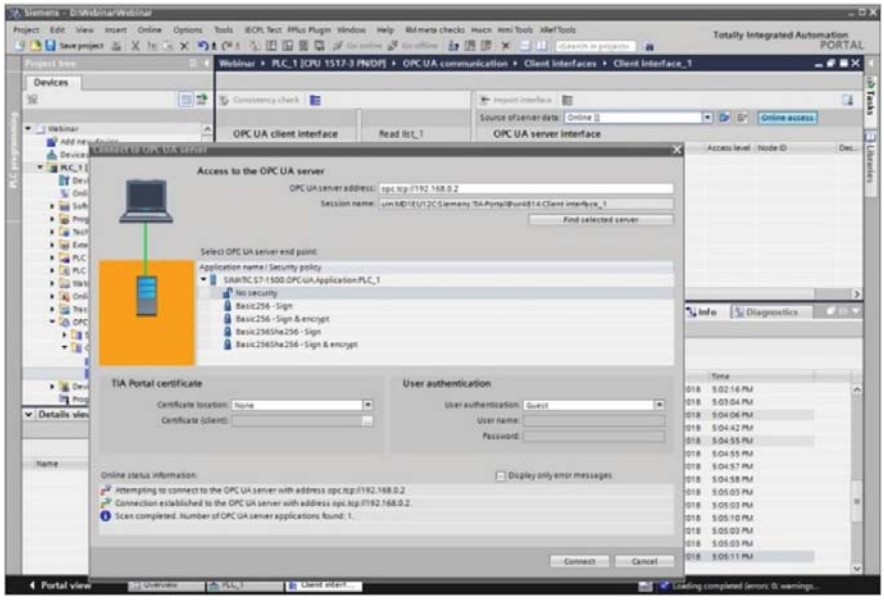


The free Siemens OPC UA Modelling Editor (SiOME) tool allows users to reload and to adapt any number of OPC UA information models or companion specifications dynamically on the SIMATIC S7-1500 controller.

Model maintenance for the SIMATIC S7-1500: Firmware with new functions

Over the course of constant further development of their SIMATIC S7-1500 controller family, Siemens have implemented new functions for communication in Firmware 2.6. The controller now offers isochronous mode on the central backplane bus, enabling demanding technology tasks to be carried out cost-effectively and compactly in the central assembly. This is particularly beneficial for dynamic control tasks which require a constant dead time. The new function additionally facilitates analog value acquisition with oversampling to detect analog signal peaks which are shorter than a PLC cycle or to record processes of analog signals which require a high sampling rate.

One of the central innovations with regard to OPC UA is the fact that in addition to the OPC UA server an OPC UA client in the complete SIMATIC S7-1500 product family, including PLCSIM Advanced, is available. This allows vertical communication to MES systems or to cloud services as well as controller-controller communication. The OPC UA client supports both method calls and read/write accesses via corresponding OPC UA communications instructions.



A wizard in the TIA Portal engineering tool supports the users with configuration of the OPC UA in accordance with the PLCopen standard.

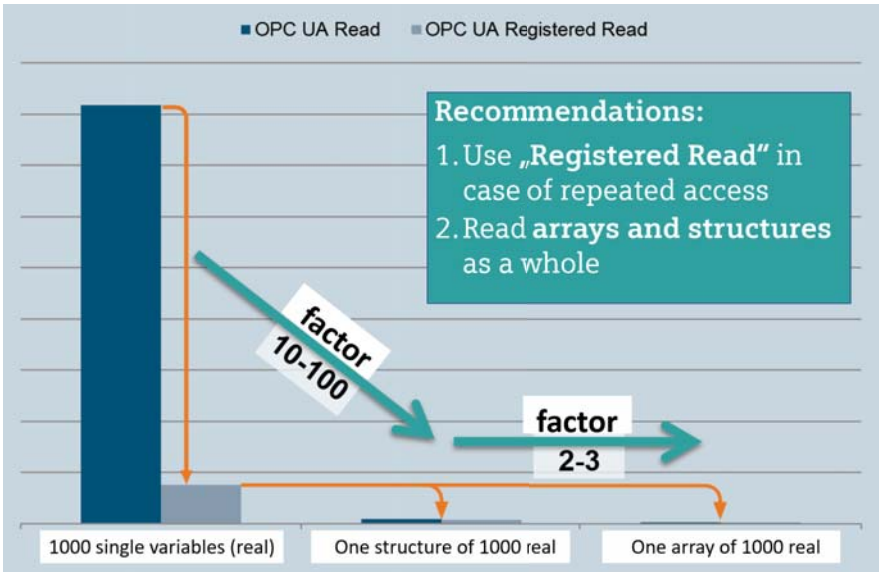
Changes to or expansions of the specification, or deactivation of the standard OPC UA interface can thus be easily updated in the firmware of the controller.

Client server architecture on the automation level

OPC UA is now established as a client/server communication for automation. This horizontal communication from machine to machine (M2M) provides each OPC UA client access to the OPC UA server data via point-to-point communication: The OPC UA client sends a query to the OPC UA server, and receives a response from the OPC UA server. This form of communication allows a reliable, secured and encrypted data exchange without any loss of data, even if the surroundings and network quality are not ideal and exhibit interference. SIMATIC S7-1500 controllers can thus function as an OPC UA server, as well as an OPC UA client in the current firmware version. This functionality is decisive in the context of Industrie 4.0, as it allows intelligent and flexible manufacturing concepts in which, for example, the workpiece is identified to the controller, and then information regarding the pending processing steps is actively retrieved via OPC UA mechanisms. Conversely, it is also possible to track each workpiece as it progresses through the manufacturing process and to read out current information pertaining to the processing status. On the one hand, this allows existing capacities to be used intelligently and flexibly, and on the other hand enables the quality to be tracked and optimized during manufacturing.

Only a few simple steps are required to configure the SIMATIC S7-1500 controller in the TIA Portal engineering tool as an OPC UA server:
The user simply activates the OPC UA server in the CPU properties, confirms the corresponding license, and then enables the variables for data access using the checkboxes in the editor.

The TIA Portal also supports the symbolic access via OPC UA, enabling data to be read out as arrays or structures and facilitating a considerably higher communications performance – by multiple powers of ten faster than the reading out of individual values, depending on the type of access and the data being read out. For access, the OPC UA server in the SIMATIC S7-1500 controller supports the browsing of CPU data, as well as Read/Write for acyclic data access and Registered Read/Write for repeated, optimized access to data – with maximum performance. The so-called subscription function is ideal wherever continuous monitoring of the data is required. Various additional OPC UA methods are available to the user for a consistent data transfer without manual handshake.



If the controller allows access to structured data, performance of the reading processes is increased considerably – sometimes by multiple orders of magnitude.

For configuration of the SIMATIC S7-1500 controllers as an OPC UA client, Siemens follow the recommendations of the PLCopen standard for implementation on a PLC. The corresponding functions can be implemented by the user with the assistance of a wizard. This is optimally supported by the TIA Portal, which provides guidance through individual dialogs.

Only specific functions such as the respective client applications must then be programmed individually. This not only reduces the time required for configuration of the OPC UA client – guided implementation of the functionality also eliminates multiple error sources.

Special starter packages are provided for first-time users of OPC UA, such as this one from Siemens with a SIMATIC S7-1500 controller and all required components and licenses.

Support in practical implementation

Optimum support for the user is of utmost priority for Siemens, as the implementation of OPC UA specifications on the automation level is often not readily possible – for example, it is possible that specifications were implemented incorrectly, were defined with little flexibility in the firmware, or devices are not certified in accordance with OPC UA. It is therefore essential that implementation of the OPC UA stipulations in accordance with the specifications is respected when selecting the components. To ensure that the communication functions with the requisite high performance, the user should also apply suitable methods and functions for the respective task. For data access and the monitoring of variables in the HMI system or on a SCADA level, the subscription model, for example, is ideal as it generates only little network load. The function does, however, generate a comparatively high load on the CPU of the controller, which could in turn cause a delay in data transfer. Access via a Read/Write or a Registered Read/Write is therefore more efficient and more reliable in many cases. To ensure optimum utilization of the OPC UA communication options, Siemens provide support for their users in selecting and implementing the correct functions with detailed documentation, informative examples, and numerous FAQs.

Quo vadis OPC UA?
As demonstrated in these examples, an OPC UA client-server architecture can nowadays be implemented with comparatively little effort on the control level. With the possibility of updating specifications in the firmware, the solutions can be adapted to the new supplementary conditions or industry-specific stipulations. Further developments in particular can also be covered for the companion specifications, which have already been announced: The Joint Working Group between PI (PROFIBUS & PROFINET International) and the OPC Foundation has already created a review version of the specification "Safety over OPC UA based on PROFIsafe" for the fail-safe controller-controller communication. Part 14 of the OPC-UA standard was released at the beginning of 2018, referred to amongst other things as the specification for Publish-Subscribe, or "PubSub" for short.

For this model, a "One-to-many" or "Many-to-one" communications mechanism is used in place of the client-server communication: A publisher provides data which can be received by any number of subscribers. The OPC UA PubSub communication can be transmitted via UDP or directly to layer 2 in accordance with the OSI model. Short cycle times are possible, depending on the respective technology being used. In combination with Time-Sensitive Networking (TSN), the extension of standard Ethernet for industrial requirements, OPC UA PubSub allows real time-capable communication on the control level and fulfills the requirement of time-critical applications. A flexible and diverse OPC UA solution on the control level now provides the users with ideal preparation for these, and subsequent changes and extensions.

If there is one thing you can be absolutely sure of: The networking and integration of data on the automation level, both among each other and with higher-level levels will also continue to increase in future. All the more reason for the control to be "fit" for digitalization already today.

Editorial version is published at IEE Industrie Engineering Effizienz 05/2019.

Siemens AG
Digital Industries
Postfach 48 48
90026 Nürnberg
Germany

Subject to change without prior notice
Produced in Germany
PDF 1019