Changeover to the OPC Unified Architecture – Seamless Migration or Bumpy Transition?

OPC Unified Architecture (UA) is the OPC Foundation's next generation technology for secure, reliable, and interoperable transport of raw data and preprocessed information from the shop floor into production planning or the ERP system. After more than four years of intensive work by several teams of experts from various international companies, the new UA specification now is in its final phase. Eight parts of a twelve-part specification have already been released. The four missing components, "Mappings", "Profiles", "Alarms & Conditions", and "Discovery" are now available as final drafts for validation. The twelve specification components, which contain numerous coding examples, are based on the tried and tested features of the current DCOM OPC technology and define a new OPC standard focused on a service oriented architecture.

Why a new OPC Specification?

OPC is the undisputed standard for interoperable data exchange, with over 17,000 OPC products, more than 3,500 different manufacturers, and worldwide millions of installed OPC based products in production and process industries, building automation, and many other sectors. This kind of success would be impossible without the many impressive advantages and strengths of this technology. Mature definitions of the "classical" OPC specifications for Data Access (DA), Alarms&Events (AE), and Historical Data Access (HDA) have been made available by the OPC Foundation to meet the diverse requirements of industry for transparent data exchange. In view of the undoubtable success of OPC and its many strengths, why do we need a completely new specification?

The following table compares the "classical" DCOM based OPC technology with the OPC Unified Architecture. Several factors clearly illustrate the new uses and opportunities offered by OPC UA and justify the rationale behind this new specification.

	"Classic" OPC	OPC Unified Architecture
Platform independence	No; use is strictly limited to Microsoft DCOM platforms (Windows)	✓ portable to any platform; the OPC foundation supplies portable UA communication stacks in C, Java, and .NET
Scalability	No; static, complex DCOM stack; very memory intensive	✓ Scalable for embedded controllers up to and including mainframes. The stack can be compiled for multi-threaded operation as well as single threading / single task operation (important for porting to embedded devices)
Address space	Separate address spaces for Data Access, Alarms & Events, and Historical Data Access; the command specification for program calls is incomplete	✓ unified address space for Data Access, Alarms & Events, Historical Data Access, and program calls; in doing so, the terminology and basic features of Data Access, Alarms & Events, and Historical Data Access have been retained;
Security	Very low; port 135 as well as others must be opened to communicate through the firewall	✓ scalable security concept based on W3C standards: User authentication, exchange of digital certificates, optional encryption of messages
Robustness	Limited; unpredictable and delayed notification of connection failures	✓ keep-alive mechanism, data buffering in case of connectin failure, fast recovery mechanism
Redundancy	No redundancy concept	✓ Client and server redundancy concept
Cascading, serialization	Cascading client-server implementations and server serialization are unspecified	✓ Concept for cascading and serialization of servers (server chaining)
Complex data, structured data types	Complex data specification exists, but was never implemented in products	✓ Complex data was an integral component of the UA address space from the start
Type information	Unsupported	✓ UA supports other organizations or manufacturer information models, e.g. Electronic Device Description (EDD) or the MIMOSA information model for system and equipment maintenance
Performance	Determined by DCOM performance	✓ OPC UA defines two transmission options: 1. Web Service Protocol SOAP (XML messages via HTTP); text based, thus easy to integrate => interoperable; a factor of several times slower than DCOM 2. UA Binary Protocol (binary encoded message via TCP/IP) with a transmission rate comparable or faster than DCOM

Table 1: Comparison of the "classical" DCOM based OPC technology with the OPC Unified Architecture.

New Applications Using OPC UA

OPC has up to now, with the exception of the OPC XML-DA specification, made use of the Microsoft Distributed Component Object Model (DCOM), which is part of the Windows operating system. The nearly "ubiquitous" Microsoft platform, even in industrial environments, is certainly one reason for the rapid distribution of OPC. However DCOM restricts the use of OPC technology to Windows operating systems. For years now, industry has been calling on the OPC Foundation to provide an OPC standard that can be utilized on different operating systems (manufacturers of ERP systems on Unix platforms and manufacturers of embedded systems with Unification Leads to Simplificationreal-time operating systems such as VxWorks, QNX, etc).

OPC UA is no longer based on DCOM but on a service oriented architecture (SOA). The OPC UA kernel is composed of a set of UA services, which form an interoperability framework. This framework forms an autonomous entity with a defined interface to the underlying proprietary technology. In this context OPC UA is more or less independent of the technology upon which the operating system is based and is easy to port. The OPC Foundation provides a C, Java, and .NET SDK (Software Development Kit) for use when porting to different platforms.
The range of services, size, performance, and platforms supported by UA servers can be modified and scaled. The server properties are specified in a profile and can be queried by the client. Exceptionally lean UA servers with only a small set of UA services, e.g. just Data

Access and minimal security, can be implemented for embedded systems with limited memory. On the other hand, memory resources are not particularly relevant for a server computer in the IT department, which means that UA servers can be very powerful and expanded to full functional capability.

Figure 1 shows how embedding a UA server in a controller or field device renders a Windows computer in the field superfluous. Vertical integration designs can be effectively implemented by cascading embedded UA servers at the process level, via UA servers at the automation level, and up to integrated UA clients in ERP systems at the company management level.

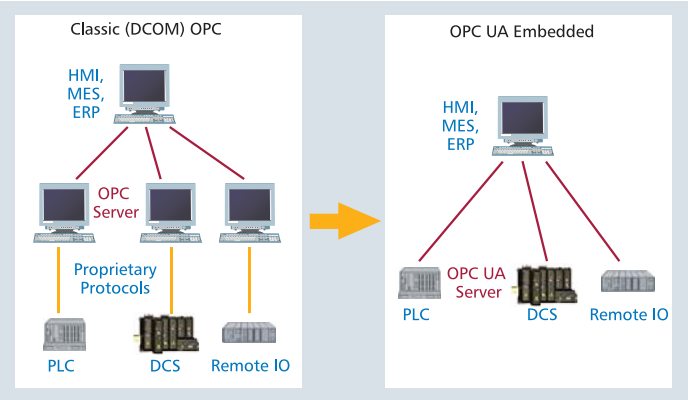

Fig. 1: OPC UA allows completely new integration designs to be implemented

Unification Leads to Simplification

The market requires the OPC foundation to provide better integration of alarms in the address space of a Data Access Server, especially for the process industry and building automation. To date three different OPC servers – DA, AE, and HDA – with different semantics have been required, for example to capture the current value of a temperature sensor, an event resulting from a temperature threshold violation, and the historic mean temperature.
OPC UA enables all three types of data to be accessed by a single OPC server. As a result UA unifies the current DA, AE, HDA models and additional program calls into a single integrated address space. This unified architecture reduces the number of OPC components to be installed and simplifies configuration and installation. UA also provides the additional option of storing a more detailed description of a data point directly in the OPC UA object, e.g. unit, scale factor etc. In this way OPC UA makes data management simpler, more centralized, and richer in additional information.

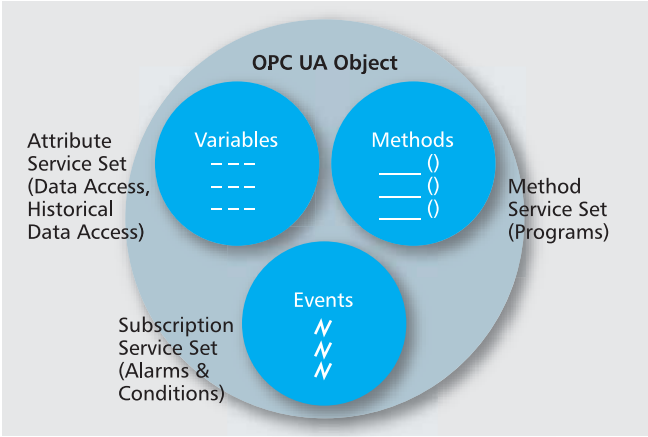

Fig. 2: OPC UA unifies and simplifies access to process data, events, historic data, and programs.

Seamless Migration Concept

An important aim of the OPC foundation is to protect DCOM OPC products, which have been developed up until now (and in the future). This is the reason why the OPC foundation has pursued a migration strategy from the outset using UA or DCOM wrappers. A UA wrapper can be thought of as a shell around a DCOM OPC server that facilitates communication with UA clients. Equally, the DCOM wrapper provides a DCOM OPC client with access to the new UA server. The wrappers are provided by the OPC foundation, but must be supplied by the server manufacturers since the OPC foundation is a not-for-profit organization and can offer neither liability nor warranty.

This wrapper has made it possible to migrate easily from the classic, DCOM based OPC technology to the Unified Architecture. However many of the previously mentioned innovations and advantages of the OPC UA are lost when mapping to the DCOM server: the uniform access to process data, historical data and alarms in one server address space, programs, type information, and structured data types are unsupported. A wrapper also represents an additional conversion layer, which reduces the transmission rate.

Softing AG offers a different migration concept with its OPC Toolbox, which is a suite of about 20 OPC toolkits for developing clients and servers for Windows, Windows CE, Linux, and other operating systems. Version 4.20 of the OPC Toolbox now has a lean, redesigned interface. In the future, OPC manufacturers who have developed a DA, AE, or XML-DA client based on the OPC Toolbox 4.20 can configure their products with OPC UA using the same programming interface and

just a few UA extensions. From version 5 upwards, the OPC Toolbox, combined DA, AE, XML-DA and UA OPC products can be used with DCOM OPC products as well as UA products without losing the new advantages and additional options of UA. Figure 3 shows the new architecture of version 5. In the final version an OPC product will be programmable in C#, VB.NET, C++ or Delphi. Version 5 of the OPC Toolbox supports the complete set of UA features. Communication is via the high-performance UA binary or via the web service protocol. Migration to the DCOM base can be performed without loss via an internal adapter.

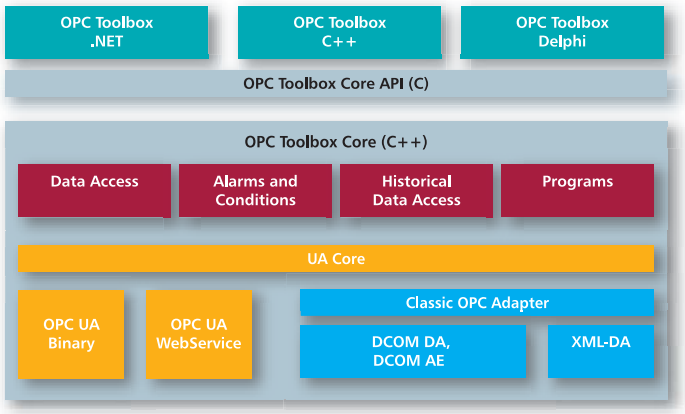

Fig. 3: In future the OPC Toolbox from Softing will enable the development of combined "classic" DCOM as well as newer UA OPC clients and servers; this results in an optimal migration strategy

Summary

OPC UA extends the existing OPC industry standard with fundamental features such as platform independence, scalability, high-availability, Internet capability, and much more. In particular, platform independence and scalability allow completely new, cost-effective automation designs to be implemented. Data in all kinds of embedded devices, e.g. embedded controllers, intelligent field devices, or PLCs can contain lean OPC UA servers that have been ported directly to the appropriate operating system. A separate Windows PC for the OPC server is not required. Vertical integration can be effectively implemented by cascading embedded UA servers at the process level, via UA servers at the automation level, and up to integrated UA clients in ERP systems at the company management level.
Over the next few years the "classic" DCOM approach will still dominate the installed base. DCOM based OPC products and UA products will coexist. DCOM OPC products will continue to be developed for process-focused sectors. After 2008, these will gradually be enhanced (not superseded!) with OPC UA implementations for the embedded sector and for the MES and ERP levels. The OPC foundation will offer wrappers for the orderly migration of DCOM OPC products to the new UA products. Tools such as the OPC Toolbox from Softing already allow access to OPC technology and the new UA toolkits guarantee an easy upgrade to UA features with all their auspicious enhancements.

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Softing is a member of the OPC UA Early Adopter Team and is jointly responsible for OPC UA SDK tests.