Industrial automation language of the future

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Communication in one form or another is commonplace throughout the natural world. Animals of all colours and creeds have different ways of communicating that allow information to be accurately portrayed to other members of the same species. However, when it comes to interspecies communication, comprehension is often far more difficult.

In the age of the fourth industrial revolution, this trait applies to machines as well. One vision of Industry 4.0 is of a highly automated, harmonious production line that relies on minimal human intervention. This goal requires seamless communication between different machines, networks and applications.

One of the most important aspects of control system operation, especially when managing distributed functions, is the ability of the system to act holistically, akin to a living organism or ecosystem.

Luckily for industry, that's where the OPC Unified Architecture (OPC UA) protocol comes into play.

In this special industry report, obsolete automation spares supplier European Automation explores OPC UA and the crucial role it plays in Industry 4.0.

OPC UA
An Introduction

When elephants re-introduce themselves to friends, they make happy trumpeting sounds and entwine their trunks as a greeting. End users didn't entirely replicate this behaviour when the industrial machine to machine (M2M) communication protocol OPC was introduced in 2008, but they were nonetheless pleased.

OPC UA is a set of industrial standards for the exchange of data between different industrial automation products from different vendors. It was developed by the Object Linking and Embedding for Process Control (OPC) Foundation - an industry consortium dedicated to the creation and updating of data transfer standards for multi-vendor, multi-platform, secure and reliable interoperability in industrial automation.

In essence, OPC UA is a protocol allowing compatible machines "of different species" to communicate and understand one another in an industrial environment.

The main benefit of the protocol is it gives engineers the peace of mind that if a programmable logic controller (PLC) is compliant with the OPC standard, it will be able to interact with the other devices without further calibration, once it has been implemented into the system. According to automation leader and OPC member ABB, in the long term, OPC UA can significantly reduce engineering costs when integrating systems that use products from different vendors.

OPC UA is the successor of Classic OPC, which was launched in 1996. One of the OPC Foundation's main goals for the new set of standards was moving from the Microsoft Windows only process exchange (COM/DCOM) to a platform independent, service-oriented architecture (SOA) for process control.

OPC UA runs on Windows, any distribution of Linux, Apple OSX and Android. Furthermore, the protocol is not limited to PC level. Embedded applications, such as PLCs and a variety of other small-scale circuitry are also compatible. By enabling such a multitude of platforms, costs for software licensing, staff training, hardware upgrades and system migration are significantly reduced.

OPC UA's scalability means that it can be used for diverse applications from the bottom to the top of the automation pyramid. This includes field level smart sensors on the plant floor and corporate network devices at enterprise level.

Accessing factory floor data from the office network or even remotely has become an increasingly important feature in the age of big data.

Devices at embedded level - such as smart sensors and actuators - generate useful raw data that when analysed. This allows companies to better understand the behaviour of processes and installations and provides data trends that can then be used to maximise profitability.

To recap - the three major benefits of OPC UA are interoperability, platform independence and scalability. These three advantages are key to the development of Industry 4.0 applications and the smart factory of the future.

What does it do?

The concept of Industry 4.0 is being driven by advanced information and communication technologies (ICT), which are becoming increasingly prevalent in industrial automation. In the modern factory, diverse machines and technologies work together to create a harmonious ecosystem.

Physical systems converge with virtual networks, creating cyber-physical systems (CPS), which are then networked and assembled in the construction of smart factories.

The salient point in this process is networking. The whole system relies on rapid inter-device communication. So how does the OPC UA facilitate this?

The OPC UA standard ensures data is collected and transported from various devices, control systems and applications from the factory floor to the office network. It has five core features that allow it to do this effectively: browsing, reading, writing, subscriptions and eventing.

Each of these profiles serves a purpose and every customer can pick and choose the feature or function they need within a system.

Browsing is the ability to locate OPC systems on a network and connect to them. Reading and writing are the abilities to send and receive data. Subscriptions allow update notifications when data or information exchange takes place. For example, the 'heartbeat function' is used for testing connections between server and client. This way, both sides know if a connection is interrupted for whatever reason. Eventing refers to the sending of alert notifications.

OPC UA for Industry 4.0

Before the first industrial revolution man and beast worked together to harvest an end product from the land. Communication between humans and horses, for example, was the same then as it is now - extremely limited and largely one directional. Thankfully, modern production methods have come a long way.

The majority of industrial automation equipment in a modern plant implements features of the OPC standards to accurately communicate with one another and maintain continuous production - a must in industries such as oil and gas. The most common functions OPC UA helps facilitate are data access, historical information logging and alarms. Coincidentally, these are also the building blocks of the smart factory.

Data access provides a method for the secure and reliable exchange of information in real-time. For example, PLCs on the factory floor control flow of production based on the information sent to them by smart sensors on the production line. This data is also sent on the fly to HMIs to be visually represented for monitoring purposes.

If a plant employs remote data access (RDA), and has the automation software infrastructure in place, plant managers don't even need to be in the factory to monitor the system. It's these kinds of advanced automated processes that OPC UA helps to make possible.

The OPC UA protocol also allows for historical data and events to be stored in a database, be it on the premises or in the cloud. Intrinsically linked to the concept of Industry 4.0 is another industry hot topic - big data. This trend sees companies storing terabytes of raw data collected from devices on the factory floor.

Big data is used in industry to better understand processes, analyse patterns and make future predictions. Once a company fully understands their production, by scrupulously analysing data from the most basic of devices, changes can be implemented to maximise productivity.

It is therefore important that factory data can be accessed from office networks on the enterprise level. OPC UA's scalability and interoperability makes this both possible and safe.

Like warning calls in the wild, alarms and conditions notify the end user when preset triggers are hit by variables such as temperature, flow or pressure. Smart sensors on the production line convey signals to HMIs to let managers know whether optimum level has been achieved or not.

Embedded OPC UA technology enables open connectivity on devices, sensors and controllers and delivers clear advantages for businesses. Thanks to the data OPC UA facilitates, end-users benefit from faster decision-making and interoperability from the outset. The integrated enterprise architecture at the heart of Industry 4.0 is becoming a reality.

Users can even try before they buy to ensure products are compatible with other OPC UA technologies. The OPC Foundation Compliance Working Group provides all members with compliance test tools (CTTs). The Foundation also runs interoperability workshops for face-to-face testing between different vendors and products. These check automated products for compliance before implementation and can save companies both time and money when building and maintaining their smart automated industrial systems.

As effective as interoperability, scalability and platform independence are when it comes to achieving Industry 4.0 nirvana, there is one more thing that needs to be taken into account. Security is always a bit of a sore spot when creating a highly automated communications ecosystem.

Security

Security is paramount in Industry 4.0 - the latest industrial revolution founded on automated and reliable transfer of information.

With companies striving for higher levels of interoperability, communication and data archiving, implementing rugged security infrastructure and staff training is essential for keeping information safe. With this in mind, levels of security are integrated into the structure of OPC UA, designed to complement the security infrastructure provided by most web enabled platforms.

OPC UA security is based on recognised standards that are also used for secure Ethernet communication, such as secure sockets layer (SSL), transport layer security (TLS) and the advanced encryption standard (AES).

OPC UA's safety mechanisms ensure the secure, reliable and platform-independent exchange of information. They are part of the standard and are obligatory for vendors. However, the user is free to combine the various security functions according to his or her specific need.

OPC UA uses a X.509 authentication standard to provide three levels of security dedicated to protecting different aspects of the communication system: user, application and transport.

The user level security ensures the authentication of clients and servers. These mechanisms handle user authentication, allocate user permissions and create detailed activity logs. This ensures unauthorised users can't access the server and is also essential for accountability.

The application level security deals with the verifiability of functional profiles. This level authenticates applications, so they are free to transfer information as needed. Through the sending of certificates, applications are recognised and verified.

Finally, the transport security level measures the integrity and confidentiality of the exchanged messages. These mechanisms help prevent common security threats, such as eavesdropping and message alteration, in which hackers gain unauthorised access to the server to hijack and alter commands.

Integrated OPC UA security features help keep information safe from hackers or malicious third parties. It helps sequence, detect and request lost data, whilst preventing message replay, so hackers can't recall information. It also initiates redundancy and executes failover support in the case of lost communications.

OPC UA's integrated security mechanisms are scalable and like most security devices, have a direct impact on system performance. Employ security overkill and the rapid communication needed to create a smart factory is impeded. Conversely, go all out to facilitate automation and speed while ignoring information security and you're leaving the door open to attack and the risk of downtime. The threat level to a company and therefore the suitable level of protection both need to be properly analysed.

Language of the future

People often have trouble saying goodbye, dogs will even pine when a beloved owner leaves their sight. In life as in industrial automation, sometimes the best thing to do is not dwell on the past. Instead, we should look forwards at the ways OPC UA will aid communication in the Industry 4.0 enabled factories of the future.

The dream of Industry 4.0 is to be able to build smart systems with reliable and self-diagnostic architecture, to create smart factories that can essentially be left to their own devices. No pun intended. Future factories could learn and make predictions based on the analysis of terabytes of raw data so they stay ahead of the curve in terms of efficiency and productivity.

Maintenance and repair could be directly initiated by the components of the intelligent factory. If spares need to be sourced, suppliers will be contacted automatically with time factored in for shipment and implementation. And with OPC compliance, certified products will be integrated almost instantly in an existing system.

Industry 4.0 could even see products controlling their production process. And why not?

By utilising different forms of communication technology, such as radio frequency identification (RFID), components could store information on how they should be processed.

At each stage of the production process RFID tags embedded in objects would be read and different machines would interpret how the product should be fashioned. Production would become incredibly flexible. However, for this to happen, standards will need to be implemented or updated so RFID can communicate with PLCs, manufacturing execution systems (MES), and further along the line, enterprise resource planning (ERP) systems.

The beasts of Industry 4.0 have been given a standardised language in OPC UA, but there is still wider adoption that could see smart technologies in industry taken to the next level. OPC UA will be critical for this success, enabling the exchange of data across all levels of an organisation.

For centuries, humans have tried to understand different species' communications so as to form bonds beyond our own kind. This has led to the domestication of dogs and cats, but largely we've failed to do as Dr Doolittle did and communicate with other species. Not to worry you, but in this respect machines have surpassed us in mere decades thanks to the OPC UA standards.